Youth Fisheries

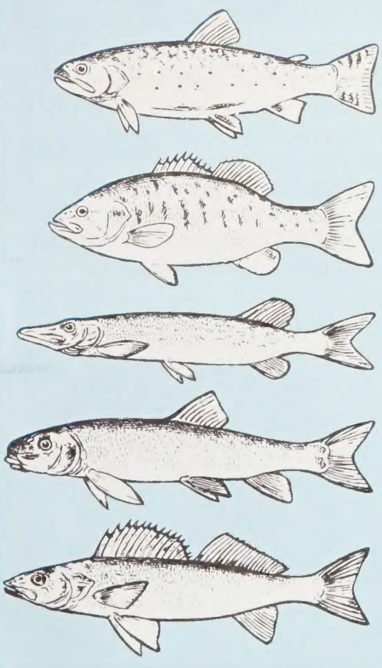
Education Program

Ministry of Natural Resources
Ontario
Lyn McLeod
Minister

YOUTH FISHERIES EDUCATION PROGRAM

Intermediate/Senior

Fisheries Branch Responds to Teachers' Needs



Can students have an adequate understanding of our natural environment without knowledge of the fish that inhabit the thousands of lakes and rivers that dot Ontario? Definitely not, say responses to a questionnaire distributed at the 1986 Science Teachers Association of Ontario Conference, several Project WILD workshops, and through the Council of Outdoor Educators of Ontario newsletter. Ninety-six per cent of the respondents reported that there is a need for fisheries education in Ontario's schools. Up to 87 per cent referred to a lack of audio-visual materials, teaching aids, and curriculum assistance on such topics as fish behavior, ecology, habitat requirements, hands-on learning activities, fish identification, fish farming, and fisheries management concepts.

In response to this need, the Ministry of Natural Resources is currently developing teaching resources which will complement Ministry of Education curriculum guidelines. A Primary/Junior and an Intermediate/Senior writing team are currently preparing teaching materials which are expected to include lesson plans, videos, posters, and other resources on a range of fish topics. The school package should be available to schools throughout the province during the 1990/91 school year.

Will these resources be useful to the average teacher? That all depends on you. This newsletter contains activities and ideas to get you started now. Use them in your classroom. How well do they work? What could we have done to make them more useful? What topics would you like to see in the future? Let us know by filling in and returning the enclosed card.

it's catching on

CURRICULUM/TOPIC CROSS REFERENCE:

	Case Study	Characteristics and Classification of Living Things	Adaptations	Interactions	Reproduction	Genetics	Control of Pests	Extinct and Endangered Species	Regulations	Technology
Grade 7 SCIENCE Characteristics and Classification of Living Things		•			•					
Grade 8 SCIENCE Adaptations		•	•		•					
Grade 9, 10, 11, 12 TECHNOLOGICAL STUDIES Guiding and Tourist Services	•	•	•		•				•	•
Grade 10 ENVIRONMENTAL SCIENCE **General** Animal Adaptations		•	•		•			•		
Continuity		•	•		•	•				
Community Ecology	•								•	
Advanced Interactions		•		•			•	•	•	
Organisms and Their Environment					•	•				
Plant and Animal Reproduction		•			•				•	
Population Ecology					•				•	
Grade 11 ENVIRONMENTAL SCIENCE **General** Aquatic Ecosystems							•			
Outdoor Skills		•							•	•
Wildlife Biology	•	•			•		•	•	•	
Grade 12 ENVIRONMENTAL SCIENCE **General** Applied Genetics		•	•		•	•				
Pests and Pest Control							•			
Advanced Applied Genetics			•		•	•				
An Aquatic Ecosystem	•	•			•		•	•	•	
Fish and Wildlife Conservation	•	•			•				•	
Outdoor Survival Skills		•							•	•
Pests and Pest Control							•			

Bridging the Gap

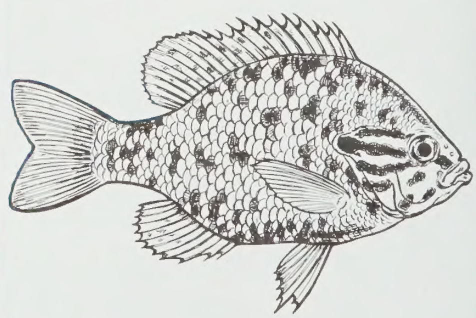
One of the drawbacks of traditional teaching methods is that students discuss theories. They don't always bridge the gap between these theories and real life. At Banting Memorial High School in Alliston, however, students have been making positive connections between what they learn in class and what they do during their own time.

"Seven years ago, we adopted a stretch of Tosorontio Creek about 11 km (7 miles) from the school," explains grades 9 through 12 Environmental Science teacher Terry McCauley. "Rehabilitating sections of this creek is an interesting and real way to teach Environmental Science. It's also a lot of fun."

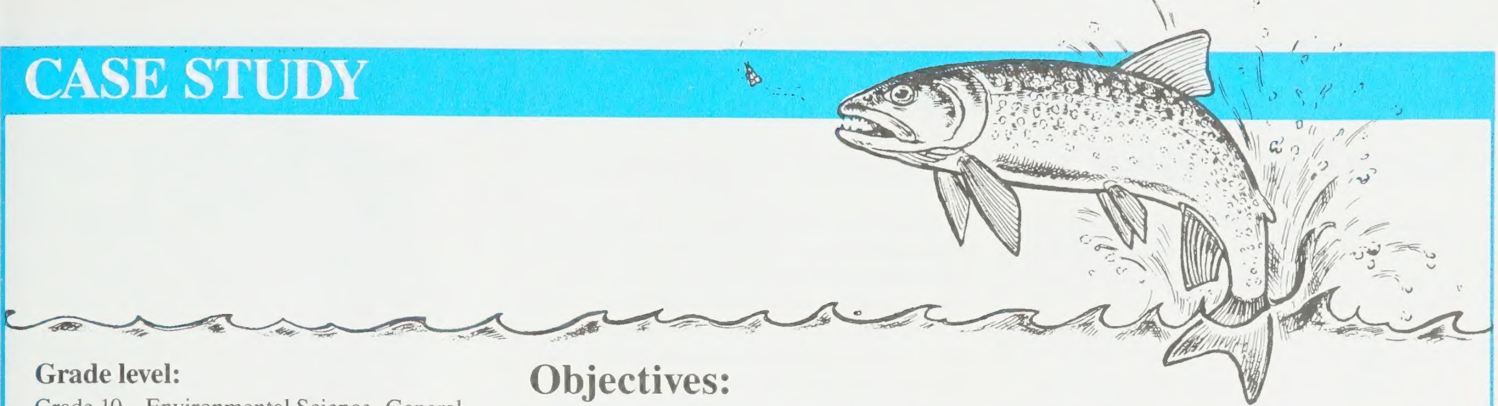
About two weeks before the planned work day, the classes visit Tosorontio Creek for an afternoon. During this preliminary inspection, McCauley explains what type of work needs to be done. "At Tosorontio Creek, students can analyse what the structures we've built in the past are doing to the stream. I encourage

them to come up with ways to improve existing structures and to recommend alternative structures." Because students participate in the planning and problem-solving aspects of the work, the project becomes theirs.

For more information about starting a Community Fisheries Involvement Program (CFIP) in your school, contact your Ministry of Natural Resources district office.



CASE STUDY



Grade level:
Grade 10 – Environmental Science, General (Community Ecology);
Grade 11 – Environmental Science, General (Wildlife Biology);
Grade 12 – Environmental Science, Advanced (An Aquatic Ecosystem, Fish & Wildlife Conservation);
Grades 9/10/11/12 – Technological Studies (Guiding & Tourist Services)

Subjects:
Civic Politics, Environmental Studies, Language Arts, Marketing, Science, Social Studies, Technological Studies

Skills:
Thinking Skills (comparing, interpreting), Communicating Skills (oral, written), Problem-Solving Skills (collect and organize information, record, evaluate/assess, synthesize/conclude, report)

Duration:
At least three 45-minute periods

Group size:
Class

Setting:
Indoors

Concepts:
Resource allocation, conservation, rehabilitation, multiple use, negotiation, technology

Key vocabulary:
Fisheries management plans, resource allocation

Extensions:

1. Prepare a newspaper collage representing the many sides of a local fisheries management issue. Develop an advertising campaign to sway public opinion toward one side of an issue.

2. Prepare a survey eliciting public opinion on a specific fisheries related issue. Administer the survey. Analyse the results.

3. Brainstorm the possible biological consequences of some of the solutions discussed. What are the short-term consequences (10 years or less)? What are long-term consequences (more than 10 years)? Which decisions have both long- and short-term consequences? Which consequences are the class willing to live with?

Objectives:

Students will be able to identify some of the issues involved in allocating fish resources (i.e., who gets what and how much?).

Method:

Students analyse one of several positions around a specific fisheries management issue and role-play one side of that issue. As part of the role-playing task, they negotiate a settlement with other players.

Background:

Conservation and rehabilitation of fish stocks are vital concerns in management. Enough fish must be conserved to maintain healthy populations of existing species. In locations where fishing opportunities are poor, it's important to rehabilitate fish species to the point where they can sustain a regular harvest without long-term stocking from hatcheries. Rehabilitation programs may require international agreements with the United States, restrictions on fishing, restoration of spawning habitat, and control of parasitic species such as sea lamprey.

Managing an aquatic environment which can support many uses such as shoreline development, boating and hydroelectricity generation, as well as supporting naturally reproducing fish populations, is challenging. Part of the job of the Ministry of Natural Resources is both to balance the often conflicting demands of native peoples, sport anglers, and commercial fishermen and to share the fish in such a way as to leave enough young and mature fish to maintain a healthy, self-sustaining fishery. Managing fish resources is difficult without ecological, social and economic knowledge. For this reason, research, assessment and information about fish, harvest, habitat and users is vital.

Materials:

Copies of your local District Fisheries Management Plan and/or District Fisheries Management Plan Summary tabloid.

Procedure:

1. Ask students to identify all the major issues in the local fisheries management plan.

2. In a classroom discussion, list the major players. How might their points of view differ?

3. Co-operatively set up a simulated fisheries management plan review. Ask students to pick roles from the ones discussed in number 2. It will be their job to further analyse their roles, interview local people with a stake in the issue, and develop a counter-proposal or amendment to the fisheries plan. Students not directly involved with these roles may write letters to the editor and/or play the parts of various news reporters/broadcasters.

4. Allow class and/or homework time for key players to research the background for their roles, and for the others to prepare their written opinions.

5. Allow two periods for discussions. Before the first meeting, key players should receive the letters to the editor and articles developed by other groups. The student playing the Minister of Natural Resources will act as chairperson. Participants must be recognized by the chair before speaking.

6. Open the meeting with a presentation of the options listed in the District Fisheries Management Plan. Other players may argue the case for their counter-proposals and/or amendments. (Depending on the group, you may wish to identify a section of the classroom as a 'Private Room' where individual interest groups may bargain with government officials and each other as the players approach a decision.)

7. Once a plan has been adopted, discuss the negotiating process. What are some of the things students learned about fisheries management decisions? What factors influenced the players' decisions? What role can the average citizen play? How can such a person increase his/her influence?

Scales Tell Tales

Trained people can read fish scales almost like a book. Here's what just one scale can reveal.

Fish scales have circular rings called annuli. During the winter, when fish grow slowly, the zones between these annuli are close together; they're also often broken and fragmented. During the summer, when growth speeds up, the zones are wider apart. Although the patterns change with feeding, growth rate, water temperatures, and spawning, you can tell the age of fish by counting the series of these zones.

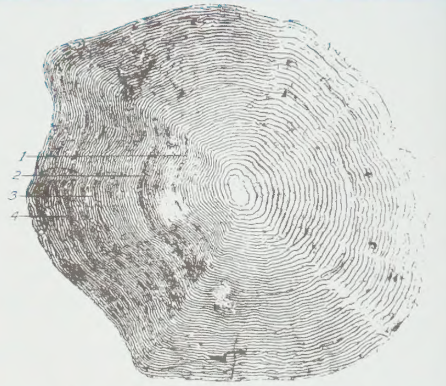
Counting zones works well as long as the fish is growing. When fish stop growing in length, however, the scales stop growing too. Within a short time, annuli become distorted and so close together that they can't be read, the outer surface of the scale begins to erode, and some of the mineral content is reabsorbed.

By examining these changes, biologists can estimate a minimum age for the fish, but can't accurately age it. The existing annuli, however, do provide a record of the fish's growth.

By examining the shape, size and growth pattern of the scale, technicians can figure out which part and which side of the fish's body the scale is from, the size of the fish, and even its sex.

The scales of each fish species have a unique shape and pattern. If one species crosses with another species, the scales on the resultant hybrid are different from those on either parent species.

Scales can show what location in a body of water a fish came from. A trained scale reader can also tell whether a fish was raised in a hatchery or in the wild.



Obtain some fish scales from your Ministry of Natural Resources district office, a local fish market, fish processing plant, or a commercial fisherman. Compare scales of different fish. Observe scales from fish of the same species. Specify criteria that technicians may use to determine what part of the fish the scales come from, the sex and size of the fish.

Scales of Justice

Two years ago, a poacher was convicted on the evidence of eight fish scales and a few fish eggs. Here's how.

In April, Conservation Officers found eight scales and some fish eggs in a car parked near a walleye spawning bed. Suspecting that the owner had been poaching spawning walleye, the Conservation Officers questioned the car owner. He claimed that he had caught a small walleye through the ice a month earlier. He placed it in his car before taking it home for filleting. According to him, the scales and eggs in his car must have come from this fish.

The MNR fisheries scientist had a different tale. He claimed that the scales were not from the same fish. In fact, the growth patterns showed that they must have come from eight different fish. And the fish weren't small. The shape of the annuli (circular rings on scales), plus the fact that part of the scales had eroded, suggested that the fish were at least 14-18 years old, and probably a lot older. Not only that, the eggs were bright orange, clear, and showed other characteristics seen only during spawning runs. The eggs therefore couldn't have come from a fish caught in March. In fact, the fish must have been caught during the spawning run.

The judge believed the fisheries expert. The poacher was fined $3200 for fishing out of season, all on account of a detailed analysis of eight fish scales and some eggs.

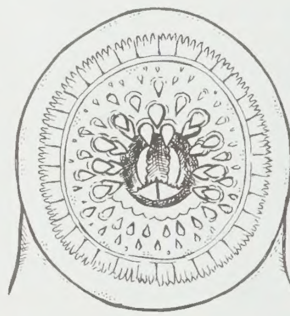
Amphibious Fish

Unlike most fish, the American eel can travel on land in wet areas. That's because the eel can absorb up to two-thirds of the oxygen it needs by breathing through its skin. An eel can survive for two to three days out of water – as long as the skin is kept wet.

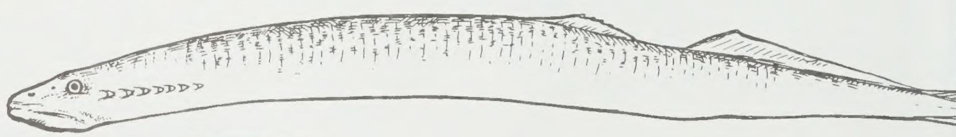
A Case of Mistaken Identity?

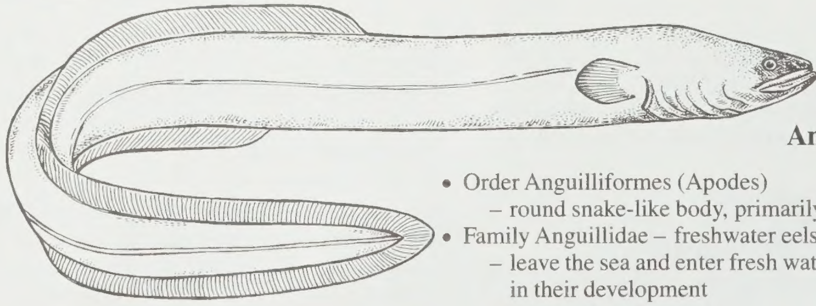
When sea lamprey first invaded the Great Lakes, anglers blamed "lamprey eels" for damaging the lake trout and whitefish populations. **Study the following chart and diagrams. Why is the sea lamprey referred to as an eel? Compare the sea lamprey and the American eel.**

Sea Lamprey


Lamprey Mouth

- Order Petromyzontiformes
  - eel-like body; adult has well-toothed, round mouth adapted for sucking
- Family Petromyzontidae
  - 30 species in eight genera
  - distributed in temperate marine and fresh waters
- Genera Petromyzon
  - one of five genera in northern hemisphere
- Species Petromyzon marinus Linnaeus
  - largest and most predatory of lampreys
- Feeding habits: parasitic, attaches self to fish, rasps hole in skin, consumes body fluids and blood
- Common names: great sea lamprey, lamprey eel, lamper eel





American Eel

- Order Anguilliformes (Apodes)
  - round snake-like body, primarily marine specie
- Family Anguillidae – freshwater eels
  - leave the sea and enter fresh water early in their development
  - return to sea to spawn
- Genus Anguilla – 16 species, one in North America
- Species Anguilla rostrata (Lesueur)
  - found in coastal areas and fresh waters from Labrador to the West Indies
  - common in Lake Ontario and other lakes that are part of the Lake Ontario-St. Lawrence River system
- Feeding habits: carnivorous, eat a wide variety of fishes and invertebrates
- Common names: Atlantic eel, eel, common eel, freshwater eel, silver eel

THINGS

The World's Slipperiest Fish

It's a worm. It's a snake. No, it's a fish.

Despite their snake-like appearance, eels are fish. In fact, they're one of the most interesting fish in North America.

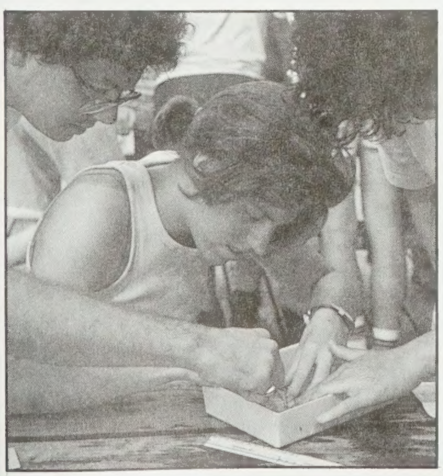
American eels hatch in the Sargasso Sea, a warm and salty stretch of brown seaweed south of Bermuda and east of Florida – part of the Bermuda Triangle. The eggs hatch into fry, then float to the surface. After a few days, they become transparent creatures about the shape of a willow leaf. These "leptocephalus" drift north with the current. A year later, they metamorphosize into transparent "glass eels." Within a few months, the glass eels turn greyish green in color. These young "elvers" seek out inshore areas and freshwater rivers.

No one is precisely sure when American eels take on distinctive sexual characteristics. Some say that the females come inland to Lake Ontario, while the males stay in the saltwater bays and freshwater streams of Quebec and the Maritimes. Others say that something about their environment makes inland eels develop female characteristics while seagoing eels develop those of males.

Whichever theory is correct, the inland eels spend 10-15 years feeding on alewife and smelt. By age 20, most are at least two metres long and as thick as a fire hose. That's when their sexual organs begin to mature. In fact, these organs gradually get larger, and the digestive organs get smaller, as the female American eels move back down the St. Lawrence toward the Sargasso Sea.

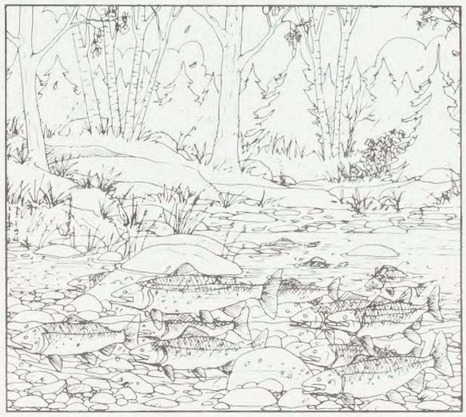
It takes several months for the adult females to reach their place of origin. There, the females lay at least five million eggs each. Then, they die, soon to be replaced by tiny young.

Using a map of North America, illustrate the place of origin and the 20-year migration pattern of the American eel. Use appropriate sketches of the life cycle and time span for each stage.



ADAPTATIONS

Saltwater Adaptation Continues



In 1957, the Port Arthur (Thunder Bay) fish culture station was raising pink salmon from the West Coast for airlifting to James Bay where the Ministry of Natural Resources hoped to develop salmon sport fishing. When the James Bay planting was finished, 21,000 salmon were left. Thinking that the West Coast salmon would never be able to survive in fresh water, hatchery personnel flushed them out into the Current River where the little fish had to run the gauntlet of hundreds of gulls. The salmon not only survived, they reproduced in such great numbers that, by 1979, they were present in all of the Great Lakes. How did this saltwater species survive in a freshwater environment?

In their natural environment, adult Pacific salmon move from far out in the salty ocean back to the freshwater rivers where they hatched. Their eggs mature under the gravel of icy freshwater streams. The young hatch, then move downstream to estuary areas where salt and fresh water meet. Before heading out to sea, the young go through some interesting changes. During a process called smoltification, they develop salt secreting cells in the gills. These and other physiological changes allow salmon to retain water in a saltwater environment, thus enabling them to survive in salty ocean waters.

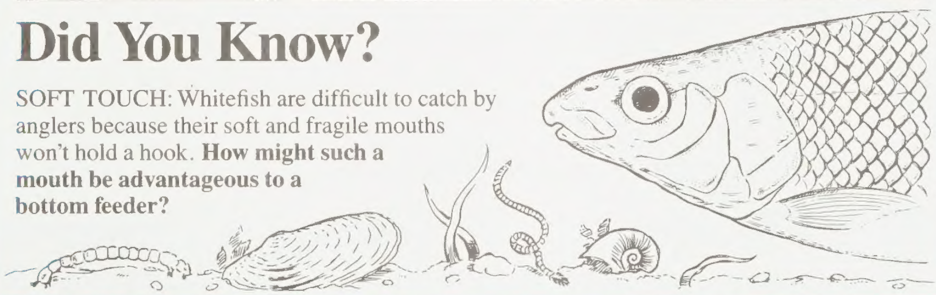
Although Pacific salmon hatched in Great Lakes' streams do not reach salt water, they still have an instinctive drive to migrate. Their bodies also undergo the physiological changes necessary for a saltwater migration. But when the salmon don't reach ocean waters, their bodies adjust to a freshwater environment.

The smoltification process is not confined to West Coast salmon. It occurs in all types of salmon, as well as in migrating rainbow and brown trout. All of these species originally spent part of their life cycle in salty ocean waters. Young fish still go through the necessary physiological changes – just in case.

Discuss the difference between environmental and genetic control of adaptations and behavior. Predict evolutionary changes in salmon. What effect might these changes have on salmon and other fish populations?

Did You Know?

SOFT TOUCH: Whitefish are difficult to catch by anglers because their soft and fragile mouths won't hold a hook. **How might such a mouth be advantageous to a bottom feeder?**

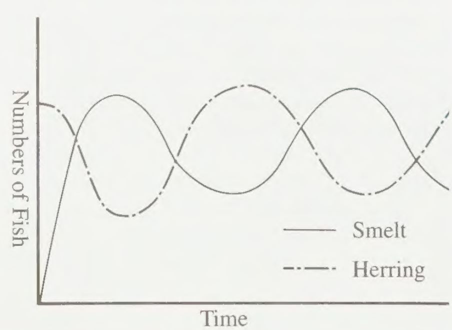


INTERACTIONS

Population Dynamics

How can introduced rainbow smelt affect a herring fishery? Smelt eat young herring. When smelt numbers are high, the herring population can decrease dramatically. If disease or sea lamprey predation reduce the number of smelt, the herring population could increase.

Collect historical and/or recent data on fish populations from your local MNR district office. Determine, through an examination of food chains and environmental changes such as shoreline alteration, what caused the population fluctuations.



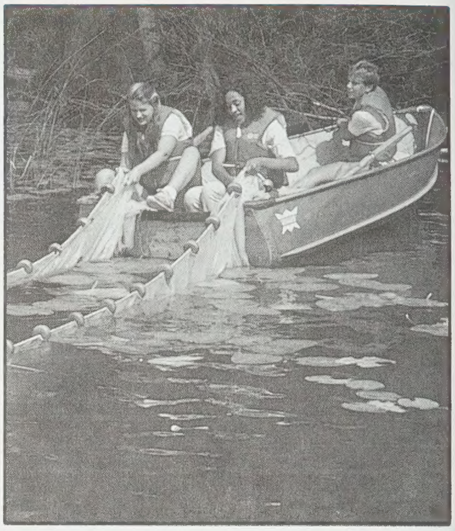
Migrating Fish Easy to See

Many fish species spend their adult years in lakes, but move into smaller rivers or streams in order to reproduce. Unfortunately, the upstream stretches of some ideal spawning streams have been blocked by old mill and hydroelectric dams, as well as by natural falls. Starting in the early 1960s, the Ontario Ministry of Natural Resources began building a series of fishways to assist fish migration around such obstructions.

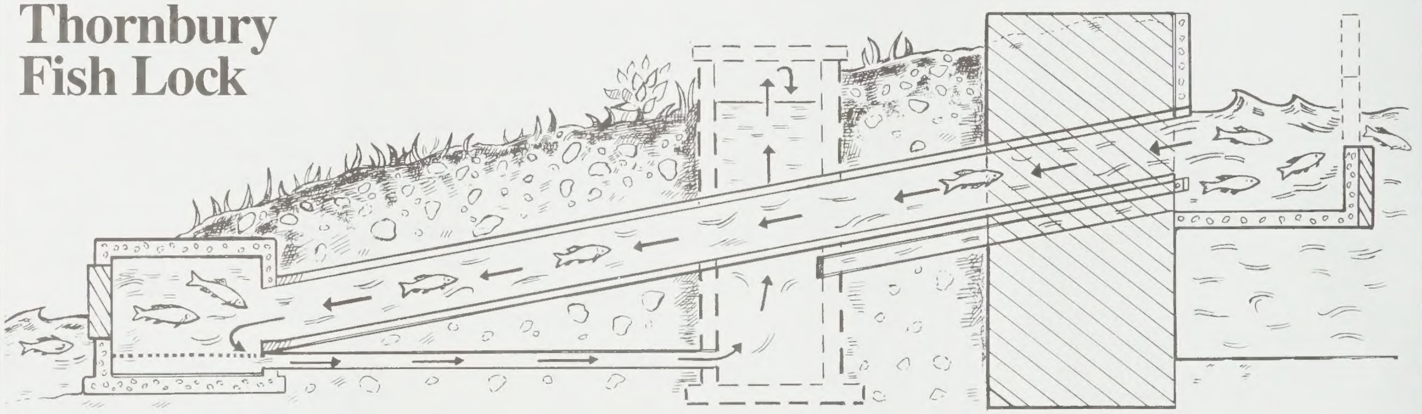
Fishways planned for species such as rainbow trout, brown trout and Pacific salmon are designed to take advantage of the jumping ability of these fish. These designs have similar features: fast-running water at the base of the fishway which attracts fish moving upstream, and a horizontal steel plate that forms an overhang which prevents sea lamprey from climbing over the fishway.

Designs planned for such species as American eel must have different features. The American eel can't jump, but it can climb. Eel ladders therefore include some way of providing leverage for climbing fish. There also must be enough moving water to attract the eels into the entry of the ladder.

There are now 26 fishways located throughout Ontario. Even if there's not one near your school, spring provides excellent opportunities for students to see migrating fish both in fishways and in areas with shallow water. Phone your local Ministry of Natural Resources district office for the timing and location of any smelt, sucker, rainbow trout and walleye spawning runs in the vicinity. During the fall, ask about herring, lake trout, brook trout, brown trout and salmon spawning. Near Cornwall, American eels climb the Moses-Saunders dam from mid-June until late September.



Thornbury Fish Lock



Fish Elevator

A dam on the Beaver River near Thornbury is too high for a cost-effective traditional fishway. Instead, it has a fish elevator. This elevator or lift operates on the same principle as a canal lock. A computer-operated gate at the bottom of the chamber is alternately opened and closed. When the gate is open, the water flowing out creates a current which stimulates fish to move upstream. When the gate is closed, the chamber fills with water until the level reaches the pond above the dam. Fish swim against the current into the pond at the top of the lift.

Fishway Comparison

Fishway	Location	Vertical height	Length	Species	Fish per year
Ganaraska Fishway	Port Hope	3.7 metres	30 metres	rainbow trout brown trout coho salmon chinook salmon	15,000 to 17,750 mostly rainbow trout
Port Albert Fishway	Port Albert	2.4 metres	17 metres	rainbow trout Pacific salmon	around 2,000
Moses-Saunders Ladder	Cornwall	28 metres	5:1 slope 135 metres	American eel	1,000,000
Thornbury Fish Lock	Thornbury	7 metres	—	rainbow trout chinook salmon brown trout	around 5,000

YOUTH FISHERIES EDUCATION PROGRAM

Intermediate / Senior

Please help us by filling in and returning this postcard.

1. Did you use any part of the newsletter in your classroom?

YES ___ NO ___

Which part or parts? ____________________

____

Comments: ____________________

____

2. What other topics would you like to see in future newsletters?

____

3. How did you receive this newsletter?

____

4. Would you like to be placed on a mailing list for future newsletters?

YES ___ NO ___

Name ____________________

School ____________________

Address ____________________

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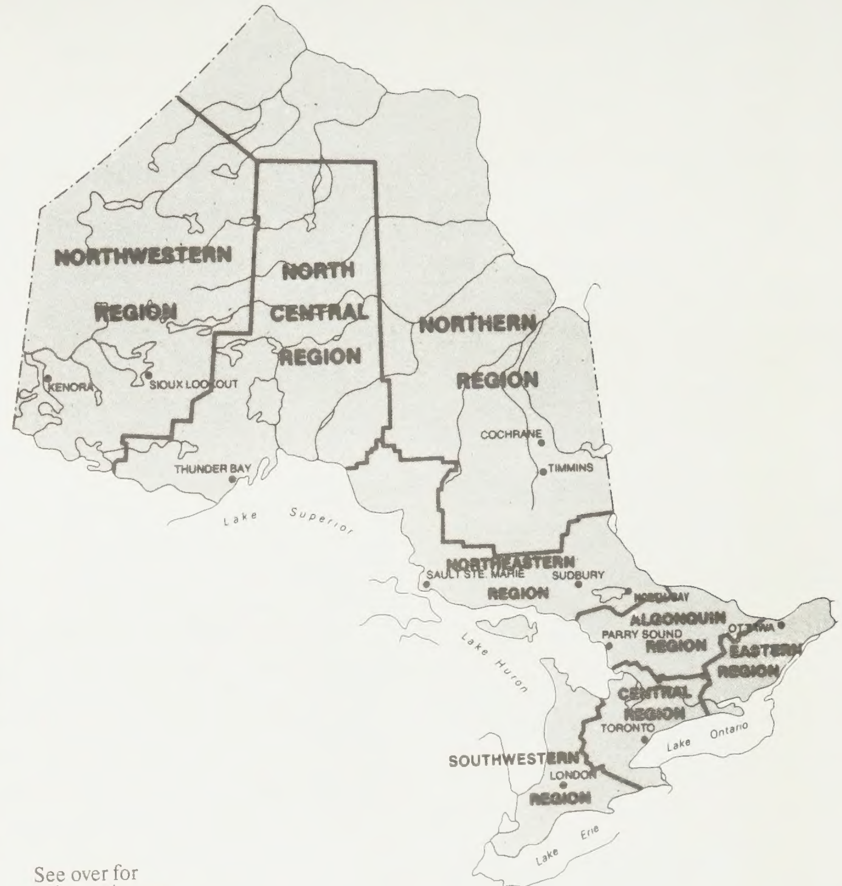
Thank you for helping us improve our intermediate / senior newsletter.

Detach Here.

Ministry of Natural Resources Administrative Regions



See over for information on the District Office nearest your school.

District Offices

NORTHWESTERN REGION
DRYDEN, 479 Government Road, Box 730 P8N 2Z4 (807) 223-3341
FORT FRANCES, 922 Scott Street P9A 1J4 (807) 274-5337
IGNACE, Box 448 P0T 1T0 (807) 934-2233
KENORA, Box 5080 P9N 3X9 (807) 468-9841
RED LAKE, Box 5003 P0V 2M0 (807) 727-2253
SIOUX LOOKOUT, Box 309 P0V 2T0 (807) 737-1140

NORTH CENTRAL REGION
ATIKOKAN, 108 Saturn Avenue P0T 1C0 (807) 597-6971
GERALDTON, 208 Beamish Avenue, W., Box 640 P0T 1M0 (807) 854-1030
NIPIGON, Box 970 P0T 2J0 (807) 887-2120
TERRACE BAY, Box 280 P0T 2W0 (807) 825-3205
THUNDER BAY, 435 James Street S., Ontario Government Building P7C 5G6 (807) 475-1521

CENTRAL REGION
CAMBRIDGE, Box 2186, Beaverdale Road N3C 2W1 (519) 658-9355
HURONIA, Midhurst L0L 1X0 (705) 728-2900
LINDSAY, 322 Kent Street W. K9V 4T7 (705) 324-6121
MAPLE, 10401 Dufferin Street L0J 1E0 (416) 832-2761
NIAGARA, Box 1070, Fonthill L0S 1E0 (416) 892-2656

SOUTHWESTERN REGION
AYLMER, 353 Talbot Street W. N5H 2S8 (519) 773-9241
CHATHAM, Box 1168 N7M 5L8 (519) 354-7340
OWEN SOUND, 611 Ninth Avenue E. N4K 3E4 (519) 376-3860
SIMCOE, 548 Queensway W., (Hwy. #3) N3Y 4T2 (519) 426-7650
WINGHAM, R.R. 5, Hwy. 4 South N0G 2W0 (519) 357-3131

NORTHERN REGION
CHAPLEAU, 190 Cherry Street, Box 460 P0M 1K0 (705) 864-1710
COCHRANE, 2 Third Avenue, Box 730 P0L 1C0 (705) 272-4365
GOGAMA, Box 129 P0M 1W0 (705) 894-2000
HEARST, 631 Front Street, Box 670 P0L 1N0 (705) 362-4346
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KIRKLAND LAKE, Box 129, Swastika P0K 1T0 (705) 642-3222
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WAWA, Box 1160 P0S 1K0 (705) 856-2396

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BANCROFT, Box 500 K0L 1C0 (613) 332-3940
BRACEBRIDGE, Box 1138 P0B 1C0 (705) 645-8747
MINDEN, K0M 2K0 (705) 286-1521
PARRY SOUND, **7 Bay Street P2A 1S4** (705) 746-4201
PEMBROKE, Riverside Drive, Box 220 K8A 6X4 (613) 732-3661

EASTERN REGION
BROCKVILLE, Oxford Avenue, Box 605 K6V 5V8 (613) 342-8524
CARLETON PLACE, 10 Findlay Ave. K7C 3Z6 (613) 257-5735
CORNWALL, 113 Amelia Street, Box 1749 K6H 5V7 (613) 933-1774
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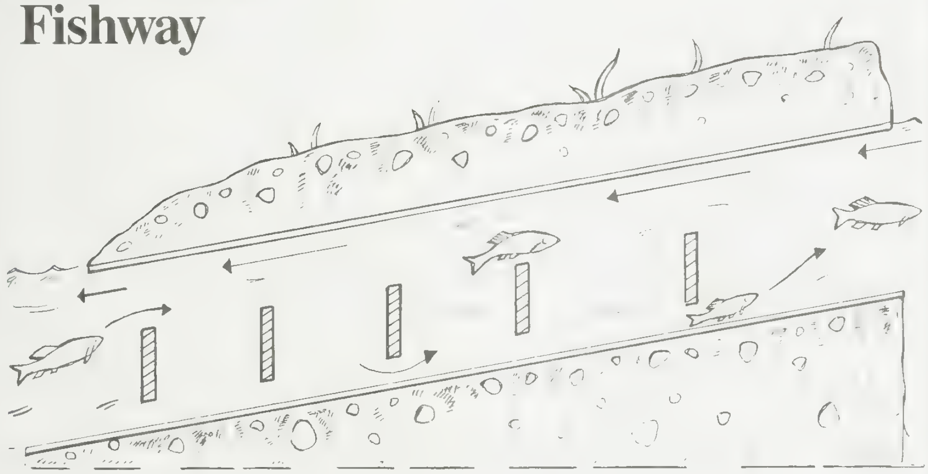
Ontario Ministry of Natural Resources
Fisheries Branch
Room 3440, Whitney Block
99 Wellesley Street West
Toronto, Ontario
M7A 9Z9

How Does Reproduction Influence Survival?

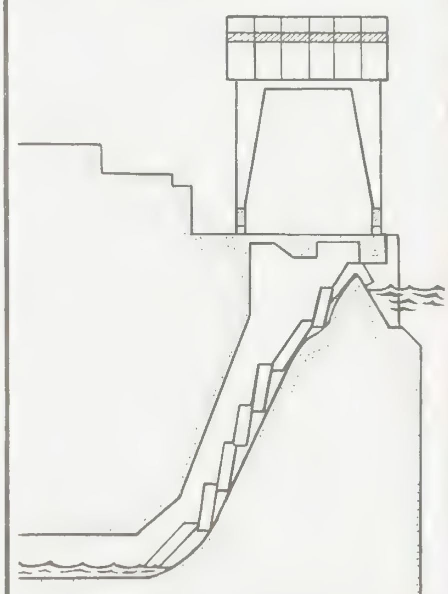
A variety of factors help fish survive over time. These factors include the number of eggs produced, the fish's age at sexual maturity, the reproductive cycle (how often and in which season the fish spawn), and the care of eggs and young. **Set up 30-year bar graphs for each fish population with an egg mortality rate of 10, 50 and 90 per cent. Each population starts with one breeding pair. Which fish species listed below seems likely to be the most susceptible to overfishing? Which will be most quickly affected by loss of spawning or nursery habitat? Which will recover the quickest?**

Species	Number of eggs	Age when first sexually mature	Average life span
American eel	5,000,000	20 years	20 years die after spawning
lake sturgeon	110,000 to 900,000	Males 7-13 years Females 14-15 years	30 years Males spawn every 2-3 years Females produce eggs every 4-7 years
rainbow smelt	10,000 to 31,000	2-3 years	2-4 years experience large die-offs immediately after spawning

Ganaraska Fishway



Moses-Saunders Eel Ladder



Ladder Challenge

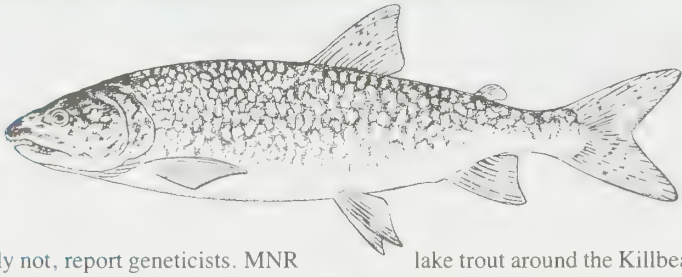
So far, the Ministry has successfully built fishways for rainbow trout, brown trout, Pacific salmon and American eels. Today's fisheries biologists are faced with a new challenge. In order to increase walleye and pike production, they would like to give these species access to upstream sections of the Thames and Grand rivers, and several tributaries running into Georgian Bay.

Here's the problem. Neither pike nor walleye jump. Nor can they cope with strong currents. A successful design must attract walleye and pike to the fishway, BUT have water moving slowly enough to allow them to get through. It must also eliminate climbing species such as sea lamprey. **Design a fishway that will answer these requirements. Enter your design in the next science fair.**

Did You Know?

THE FIRST HATCHERY, NEWCASTLE, ONTARIO – In the mid-1860s, Samuel Wilmot stripped the eggs from female Atlantic salmon, then artificially fertilized them with milt from males. These eggs were hatched, along with some naturally spawned eggs, in a wooden trough he had constructed in his cellar. In this experiment, only five per cent of the naturally spawned eggs survived to hatch. Seventy-five per cent of the artificially fertilized eggs survived. His findings led to the development of modern fish culture stations.

Are All Lake Trout the Same?



Definitely not, report geneticists. MNR geneticists have studied 29 different stocks of lake trout in provincial waters. Not only did these stocks vary in genetic makeup; some showed physical differences which included variations in coloring, shape, number of scales, and size of fins.

In Lake Huron, there's a unique stock of lake trout around the Killbear area of Parry Sound; there's another in Iroquois Bay. Lake Superior has many distinct stocks of lake trout, including those around Michipicoten Island, Slate Island, and Caribou/Hare Island. Lake Simcoe has its own unique lake trout, as do many other lakes around the province.

Selecting Desirable Traits: A popular double cross

It all started because sea lamprey were killing Great Lakes lake trout at a faster rate than they could reproduce. Added to this stress was heavy fishing pressure. If lake trout were able to reproduce faster, biologists speculated, they might have a chance to survive to maturity, thus maintaining a stable population.

Great Lakes lake trout take six to seven years to reach sexual maturity. Brook trout mature in only two years. Although scientists were "tipped off" that a naturally occurring hybrid was possible, they intentionally cross-bred these two closely related species.

The result was splake, a hybrid that matured in three to four years. The term applied to the cross of the two species when the next generation of fish is produced is the first filial generation, or F1. This F1 hybrid grew fast, making the anglers happy. Unfortunately, although it could reproduce, it was usually fished out before it could spawn successfully. Back to the drawing board.

Part of the difficulty was in the splake's reaction to its environment. Like the brook trout parent, F1 hybrids tended to stay close to the surface where they were vulnerable to fishing. In order to survive in the Great Lakes, they needed to gain the ability to dive deep in water depths of more than 20 metres.

Biologists crossed splake back to native lake trout. What resulted was a fish that still matured earlier than lake trout and could survive long enough to reproduce. This lake trout "backcross" has been stocked where native lake trout have disappeared. It's one example of how genetics can improve on nature by speeding the results of natural selection.

Select characteristics from Ontario fish species to create a fish that swims quickly, eats algae, matures at three years of age and reproduces every two years. What possible changes would occur if this species was introduced into the ecosystem?

Maintaining Genetic Diversity

In the wild, if one pair of lake trout produce another pair of lake trout which survive to maturity, we might expect lake trout stocks to remain reasonably stable. In the laboratory, biologists can rear up to 4,000 fish from just one mating of that original pair. While such increased numbers may have their advantages, they also have a genetic impact that's not quite so advantageous. Raising a lot of fish from only a few parents decreases the amount of genetic variability compared to wild fish. Fish that are too closely related or inbred can have certain problems. They can have an increased chance of physical deformities, a lower survival rate, and can be more susceptible to disease.

In order to prevent the problems that result from inbreeding, biologists prefer to start with more than one hundred fish. These fish are chosen from different genetic stocks. Inbreeding is then minimized by the regular addition of wild stock, plus rotational cross breeding. Here's how it works.

Imagine a brood stock divided into three groups: A, B, C. In the first year, biologists breed A females to C males, B females to A males, and C females to B males. The resultant fish are bred in the same way.

Cross 1:

♀ A × ♂ C = A^1

♀ B × ♂ A = B^1

♀ C × ♂ B = C^1

Cross 2:

♀ A^1 × ♂ C^1 = A^2

♀ B^1 × ♂ A^1 = B^2

♀ C^1 × ♂ B^1 = C^2

Did You Know?

1. Fish species are composed of genetic sub-units called stocks?
2. Lake Ontario once had lake trout stocks that were genetically different from stocks found in Lake Huron and Lake Superior? Lake trout were lost in Lake Ontario due to lamprey predation and overfishing. Because of this genetic difference, returning lake trout to Lake Ontario was no easy task. Biologists wanted to find lake trout that had adapted to life in a lake that was both geographically close to and had a similar glacial history to Lake Ontario. They finally found a match: Seneca Lake in New York State.
3. Walleye from the Vermillion River grow faster, and sexually mature at a younger age than walleye in other inland waters such as the French River? These differences may be under both genetic and environmental control.

   Obtain samples of fish from commercial fishermen, anglers, and/or a local fish market. Try to get samples of fish caught and/or raised in different parts of Ontario. Examine them for similarities and differences. Graph observations to show the variation in one species.
4. Many species considered 'trash' fish in Ontario are highly valued in other countries? Carp and burbot are delicacies in Europe and Asia. Freshwater eels are smoked, jellied, deep-fried and eaten sushi-style by both Europeans and Japanese.

I Love To Go A Wandering

A rainbow trout planted in Erieau on Lake Erie travelled from Erieau to Niagara Falls, over the falls, across Lake Ontario to Port Hope, then several kilometres upstream. **On a map of the Great Lakes, map the route the fish might have taken. Estimate the distance.**

Biologists believe that the instinctive move downstream is in the genetic makeup of some species. Sea run salmon make their way from far out in the ocean usually back to the exact stream where they hatched. Chinook salmon planted in Lake Huron appear to circle the lake annually. They move from their spawning grounds in the North Channel, to the south end of the lake, then back to the North Channel in time for spawning season. **Map this route. Calculate whether these salmon travel further than the rainbow trout.**

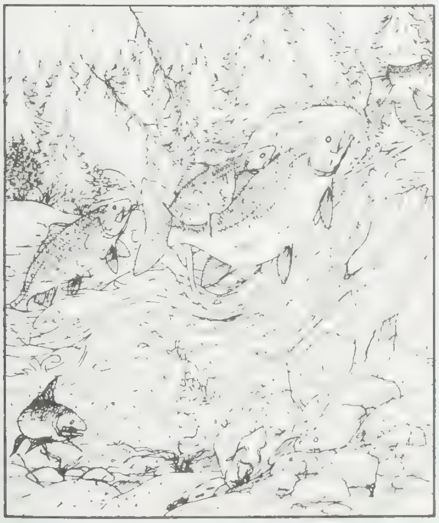
How are the bodies of these fish, and their life cycles, adapted for swimming long distances?

Salmon Encore

When settlers came to Lake Ontario before the 1800s, they found the clear cool streams teeming with giant Atlantic salmon. Due to a series of problems that included habitat degradation and over-harvesting, these salmon were extinct by the turn of the century.

Ninety years later, we know a lot more about fish management. Thanks to increased habitat protection and the partial restoration of streams along the north shore of Lake Ontario, Ontario may again provide suitable habitat for Atlantic salmon. Unfortunately, the original genetic strain disappeared about 1898. To replace them, the Ministry of Natural Resources has collected a variety of salmon eggs from sea-going salmon from Maine, and from land-locked salmon from both Maine and New York State. Using all of these stocks, Ministry of Natural Resources staff intend to reintroduce Atlantic salmon to several Ontario streams in 1988.

What are the factors influencing the survival of these fish? Design a management plan that will ensure Atlantic salmon will be returned and successfully established in Ontario streams.



A Chemical For the Job

Mercury, lead, dioxin, toxaphene, mirex (dechlorane), dichloro-diphenyl-trichloroethane (DDT), polychlorinated biphenyls (PCBs). All of these manufactured substances are harmful to fish. But at least one product of technology has also saved thousands of kilograms of fish. This is 3-tri-fluoromethyl-4-nitrophenol (TFM), a compound that, used in correct concentrations, kills unhatched sea lamprey.

The sea lamprey is a parasite with a sucker-like mouth lined with sharp teeth. Using this mouth, the lamprey attaches itself to a fish, pierces the flesh, then sucks out both blood and bodily fluids. Once finished, the parasite detaches itself and swims away, leaving a wound which may heal, leaving a scar.

Sea lamprey scars were first noticed on Lake Ontario fish around 1880. Lamprey moved through the Welland Canal into Lake Erie around the turn of the century. Spreading rapidly through the Great Lakes, they had almost eliminated the native lake trout population before Canadian and American scientists found something to control them.

That something was a chemical compound discovered after six frustrating years of research. Each spring, TFM is carefully added to creeks where sea lamprey spawn. By reducing the numbers of young lamprey, it helps to control sea lamprey predation on fish species.

Investigate how TFM kills unhatched sea lamprey. What is the active ingredient? What are its advantages/disadvantages? Is it used in other pesticides? Describe some non-chemical alternatives to TFM.

Black Spot Parasite – When Shall We Three Meet Again?

Though harmless to people, one commonly found fish parasite needs three different hosts in order to complete its life cycle. The cycle starts when a mature adult lays eggs in the intestine of a bird. The bird excretes these eggs into the water, where, after 21 days, they hatch into larvae which are covered with fine hairs that help them move. In order to survive, these larvae must find a suitable snail. Inside the snail, the larvae migrate to an organ or suitable tissue, then develop a hollow sac-like body. The sac-like body produces the next stage, which further develops in the snail before escaping into the water.

If the parasitic larvae accidentally contact a target fish, they burrow into its skin or flesh. Each one surrounds itself with a thin wall or cyst. In response to local irritation, the fish surrounds the larva with black pigment cells. This infected area produces the black spots which give the parasite its name: Black Spot Parasite. The black spot does not harm the fish, nor will fish die from it. Although a fish might die during the burrowing stage, if it were heavily infected by large numbers of larvae, this is unlikely to occur in the natural environment.

When an infected fish is eaten by the species of bird involved in the life cycle (a belted kingfisher or common loon), the wall of the cyst is digested. The young parasite escapes either into the bird's mouth or its intestinal tract where it develops into an adult, matures, lays eggs, and begins the cycle anew.

If humans eat the parasite, it won't harm them. That's because humans aren't part of the life cycle. Fish, certain snails, and fish-eating birds are. If the parasite doesn't contact each of these animals in the correct order, it won't mature. To control the black spot parasite, it's therefore necessary to minimize one of its hosts. In some areas, copper salts have been used to control the snails on which the parasite depends. Such applications are illegal in Ontario without a permit from the Ministry of the Environment.

Outline the life cycle of the black spot parasite, showing its hosts and appearance. How is this parasite dependent on other organisms? Discuss why pesticides are not an effective method of control. Investigate other common fish parasites.

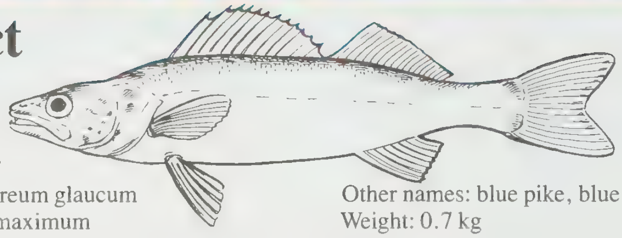
Cross-section of black spot cyst in skin of fish

Endangered Fish

The Committee for the Status of Endangered Wildlife in Canada (COSEWIC) lists species that are extinct, extirpated, endangered, and threatened. According to COSEWIC, extinct species no longer exist anywhere. Extirpated species no longer exist in Canada, but may exist somewhere else. Endangered species are threatened with immediate extinction owing to the action of humans. Threatened species are likely to become endangered if factors affecting their vulnerability are not reversed.

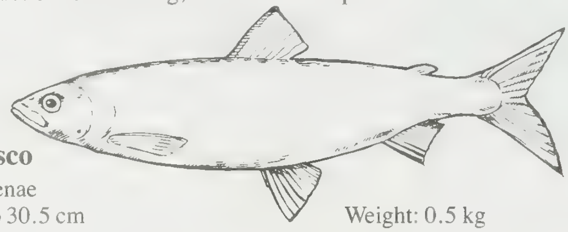
Although no Ontario fish is currently protected by the Endangered Species Act, because only plants and animals are covered, three native fish are now officially extinct. These are the blue walleye, the longjaw cisco, and the deepwater cisco. A fourth, the aurora trout (a variety of brook trout), is listed as endangered. Another seven are considered threatened. These include the deepwater sculpin, Lake Simcoe whitefish, shortjaw cisco, shortnose cisco, blackfin cisco, black redhorse (a sucker), and Opeongo whitefish.

Extinct



Blue Walleye

Stizostedion vitreum glaucum
Other names: blue pike, blue pickerel
Length: 34 cm maximum
Weight: 0.7 kg
Coloring: steel to slate blue back, blue to silvery blue sides, silvery to white belly
Habitat: lakes Erie and Ontario, lower section of Niagara River
Last seen: Lake Erie 1965
Reason for extinction: overfishing, Lake Erie eutrophication



Longjaw Cisco

Coregonus alpenae
Length: 26.7 to 30.5 cm
Weight: 0.5 kg
Coloring: green or blue back, silvery sides, white belly
Habitat: deeper areas of lakes Michigan and Huron, some in Lake Erie
Last seen: Georgian Bay 1975
Reason for extinction: overfishing, sea lamprey predation, possible hybridization with other cisco stock

Gone But Not Forgotten

"If I knew then what I know now." Usually the refrain refers to past mistakes we could have avoided – if only we had the information we have now. Among fish biologists, the demise of the blue walleye precipitates such a refrain.

The blue walleye is – no, was, a close relative of the still common "yellow" walleye. Around the turn of the century, it began experiencing problems which gradually led to its disappearance.

Although blue walleye catches were officially regulated as far back as 1889, the regulations were not enforced after 1914. From 1950 on, the fishery was difficult to regulate, due to more effective fishing techniques. As a result, blue walleye were commercially harvested in high numbers: 11,000,000 kg or about 27,000,000 fish in 1915, 12,000,000 kg in 1936, 11,000,000 in 1944. During this period, the size of the blue walleye harvest fluctuated wildly.

Today, biologists agree that the size limit was incorrect. The legal size was 27.9 cm. This meant that a large proportion of the population was harvested before the adults had a chance to spawn. Still, blue walleye might have survived had it not been for a second major threat.

By the middle of the 1900s, human activity in the Great Lakes watershed had altered the Lake Erie habitat. Agricultural, urban and industrial activity had increased the flow of nutrients into the lake. This led to a change in the plankton composition, which resulted in the production of excessive organic matter. The organic surplus settled to Lake Erie's bottom. As it decomposed, the matter depleted Lake Erie's oxygen supply. It also released nutrients back into the water. These nutrients stimulated growth of organic material such as algae, which further depleted the oxygen supply when decomposing.

Blue walleye were adapted to slightly turbid water where they could find their prey by sight. They needed water of lower temperature (15.6 to 21° C) and adequate oxygen concentrations. The eutrophication of Lake Erie decreased the amount of suitable blue walleye habitat. At the same time, the number of yellow perch, white bass, alewife and rainbow smelt increased. All of these fish fed on blue walleye young.

Had the legal size been raised to 34.3 cm, the blue walleye may have survived. Unfortunately, this knowledge came too late.

How can we apply the knowledge learned as a result of the blue walleye extinction to reduce the possibility of other fish joining the endangered list? (See "New-wave Regulations Reflect New Knowledge.")

Back From Extinction

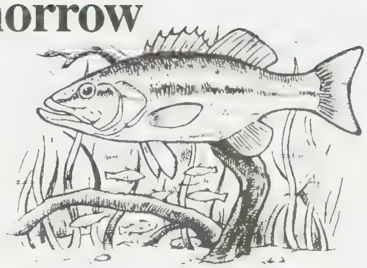
Although the blue walleye is gone from Lake Erie, at least one Ontario stock has been saved by the timely intervention of the Ministry of Natural Resources.

Until 1971, a unique type of brook trout called the aurora trout inhabited four lakes in northeastern Ontario. Acid rain completely eradicated the aurora trout in these lakes. Fortunately, staff at the Hill's Lake Fish Culture Station cultured enough fish for a comeback. Working with only half a dozen females to supply eggs, they raised enough aurora trout to stock several lakes in the Timmins and Gogama areas. There, aurora trout have been doing so well that controlled fishing opened in August 1987.

Although the aurora trout is not extinct, its existence depends on regular stocking with hatchery-cultured fish. That's why it is listed as an endangered stock.

Describe methods other than stocking which would maintain endangered fish populations.

With One Eye On Tomorrow



What is considered when designing fishing regulations? Ministry of Natural Resources officials perform a delicate balancing act among sometimes conflicting factors. First, the allowable catch must be shared among interested user groups. The amount of that catch must be determined carefully enough to leave sufficient mature fish and young to ensure future fishing. It must also make allowances for poor weather, possible environmental catastrophes, or the accidental introduction of a foreign species.

In order to balance these three considerations, the MNR uses two types of regulations. BROAD SCALE REGULATIONS cover a wide geographical area. These include species limits, fishing seasons, fishing gear restrictions, etc.

LAKE OR STREAM SPECIFIC REGULATIONS protect endangered stocks such as the aurora trout, provide maximum protection during spawning times, and/or make sure that enough adult fish survive to provide both a stable population and a trophy fishery.

In the future, MNR fisheries regulations will include a combination of broad scale and specific regulations. In order that everyone understands and knows about any new regulations, announcements will be preceded by multi-media (newspapers, radio, television) advertising that encourages public compliance and support.

If such conservation measures are to succeed, anglers must learn to check regulations before fishing in unfamiliar waters. Such anglers will be just part of a more knowledgeable and better informed public who will receive a great deal of enjoyment from their fishing experience.

Read the "Sport Fishing Regulations Summary 1988." How can such fisheries regulations benefit aquatic ecosystems? How can they compensate for the impacts of human exploitation?

Did You Know?

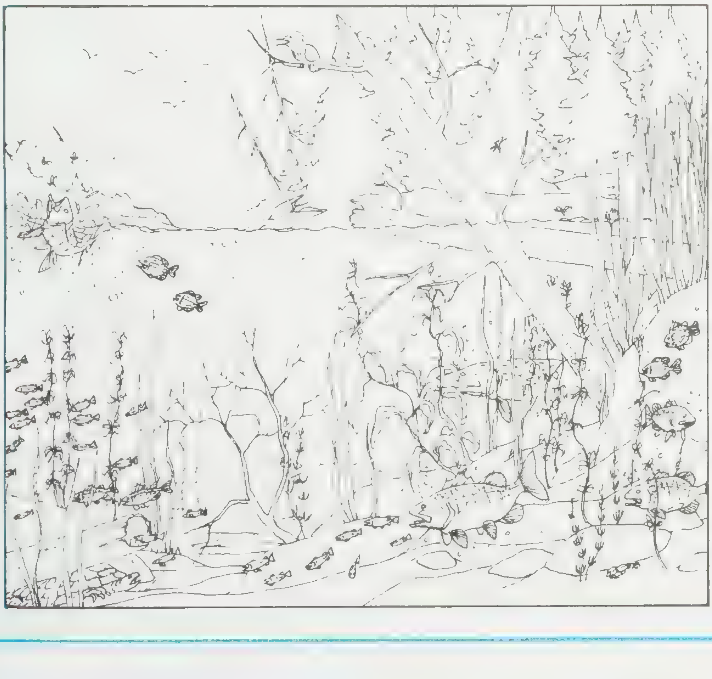
1. HEADLIGHT LAW: Because some fish are more susceptible to night angling than others, new fisheries regulations will restrict angling in some lakes to daylight hours. These are defined as half an hour before sunrise to half an hour after sunset to provide breeding stock with better protection. Sound familiar? It's the headlight law put backwards.

2. A fish SANCTUARY is a location in a lake or stream that has been set up to protect certain fish species. A fishing PRESERVE is stocked with hatchery fish for season-long fishing.

3. AFFIRMATIVE ACTION AMONG FISH? – The male smallmouth bass guards his young on the nest in June. If he is caught, or distracted for even 30 seconds, the eggs or fry could be eaten by nearby fish. That's why it is so important not to angle for bass before the fishing season opens.

New-wave Regulations Reflect New Knowledge

In the past, the Ministry of Natural Resources imposed minimum size regulations that allowed fish to spawn at least once before they were caught. In the mid-1940s, walleye fishing was limited to fish 35 cm and over. By 1954, there were few walleye over 33.75 cm; anglers were complaining about small fish, and fishing was poor. **Why wasn't the size limit working? How did this kind of regulation contribute to the extinction of the blue walleye? (See "Gone But Not Forgotten.")**



Stress May Trigger Bleeding

Brook trout migrating from the salt waters of Hudson Bay into the spawning streams of Northern Ontario experience high mortality rates from angling. Fifty per cent of the fish caught on the traditional treble barb hook die, even when quickly released. Other fish species have a 90-per-cent survival rate from catch-and-release fishing.

Scientists have identified higher than normal levels of anticoagulant in the blood of migrating brook trout. Although they don't yet know why the anticoagulant appears, they suspect it may be related to the high amount of stress experienced during a migration that includes more than 100 km through changes in water depth, temperature and salinity.

New fishing rules now regulate gear north of 54° latitude, which includes Hudson Bay, so that anglers may possess and use only single barbless hooks which reduce the incidence of bleeding to 10 per cent from 60 per cent.

Explain how biological research might contribute to the development of new fisheries regulations. What might these involve? How might they improve a local fishery?

TECHNOLOGY

Something Fishy About High Tech?

No longer content with a hook and line, some modern anglers are using technology to improve their chances of catching a big one. There are underwater sonars that produce a TV image of the bottom and of any object suspended in the water. Some even beep when the boat passes over a fish; others include a split screen that allows anglers to zoom in for a close-up view of the fish they're trying to catch.

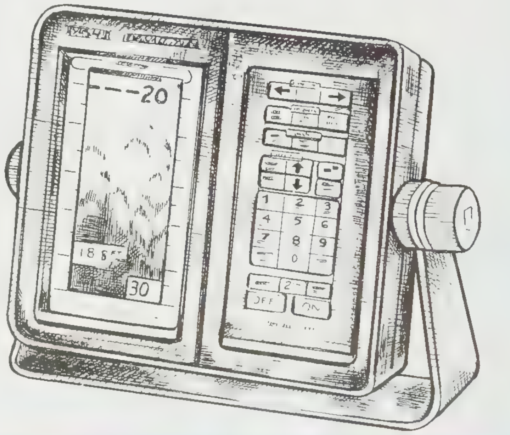
Modern scents mask the human odors that repel fish. Some trigger fish feeding behavior and/or make them use aggressive behavior, thus increasing their chances of being caught by anglers.

Meters measure the amount of dissolved oxygen in the water. Since fish can live only in locations with a certain amount of oxygen, this prevents anglers from wasting valuable time fishing at depths devoid of fish. Electronic temperature gauges help anglers find the zones where their target species are likely to be found. A color selector can also indicate which lure is likely to do best under specific water conditions.

There are bait casting reels with built-in computers that record the distance of a cast, the surface water temperature, and even when it's time to go home. A bass computer lists the time of day, plus the depth and clarity of the water. Using this information, the computer chooses the color and type of lure best for fishing for bass under current conditions.

Yes, the technology is there. But it takes an experienced angler to know how to use and interpret it. That's why technology can never replace important hands-on experience. It can sure enhance it though.

Debate the following: Is it fair game to fish with fish finders and chemical scents? What future impacts might such fishing methods have?



Fish in the Classroom

Unless you have written permission from your local Ministry of Natural Resources district office, it is illegal to keep most Ontario fish species live in your classroom. If you prefer observing native species, you may legally obtain bait fish from a baitfish dealer. Before doing this, however, consider the drawbacks. Bait fish aren't good pets. They may survive for only two to three weeks. Not only do they require temperatures lower than those found in most classrooms (16.7° C./ 62° F.), they're prone to diseases which cannot be easily treated. In addition, you can't return bait fish to the wild without written permission from your local Ministry of Natural Resources district office. If you would like further information about the regulations for catching, transporting, possessing, culturing, and releasing native fish species, contact the Ministry of Natural Resources district office most convenient to your school.

Single copies of this publication are available at no charge from the Ministry of Natural Resources Public Information Centre, Room 1640, Whitney Block, 99 Wellesley St. West, Toronto, Ontario M7A 1W3.

Bulk orders may involve charges.

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Cette publication est egalement disponible en français.

RESOURCES

- "Fish Of Ontario." Full color bilingual poster. Available from the Ministry of Natural Resources. Contact either your local district office or The Public Information Centre, Ministry of Natural Resources, Room 1640, Whitney Block, 99 Wellesley Street West, Toronto, Ontario M7A 1W3.
- "Sport Fishing Regulations Summary." Free from the Ministry of Natural Resources. See above.
- "Gone Fishing — Fish Going." Full color poster in English only. Free from the Ministry of the Environment. Contact either your local district office or Public Information, Ministry of the Environment, 135 St. Clair Avenue West, Toronto, Ontario, M4B 1P5. Telephone (416) 323-4321.
- Freshwater Fishes of Canada. Scott, W.B. and E.J. Crossman. 1973. Ottawa. Fisheries Research Board of Canada. $24.95.
- Investigating Aquatic Ecosystems. Andrew, W.A. and S.J. McEwan. 1987. Scarborough: Prentice-Hall Canada Inc. $19.98.
- Fisheries' Education Information: If you would like further assistance, contact the Fisheries Education Specialist, Ministry of Natural Resources, Room 3440, Fisheries Branch, Whitney Block, 99 Wellesley Street West, Toronto, Ontario, M7A 1W3. Telephone (416) 965-7885.
- Leslie M. Frost Natural Resources Centre, Dorset, Ontario. Situated east of Huntsville on Highway 35, this outdoor education residential centre offers fish-related programs for students from grade 6 to OAC. There are also numerous professional development workshops available to teachers. For details, write to The Director, Leslie M. Frost Natural Resources Centre, Ministry of Natural Resources, Dorset Ontario, P0A 1E0. Attention: Barrie Martin. Telephone (705) 766-2451.

Ontario
Ministry of Natural Resources
Lyn McLeod
Minister

YOUTH FISHERIES EDUCATION PROGRAM

Primary-Junior

What is the world like from a fish's point of view?

Help your students create a classroom lake that shows them.

Fisheries Branch Responds to Teachers' Needs

Can students have an adequate understanding of our natural environment without knowledge of the fish that inhabit the thousands of lakes and rivers that dot Ontario? Definitely not, say responses to a questionnaire distributed at the 1986 Science Teachers Association of Ontario Conference, several Project WILD workshops, and through the Council of Outdoor Educators of Ontario newsletter. Ninety-six per cent of the respondents reported that there is a need for fisheries education in Ontario's schools. Up to 87 per cent referred to a lack of audio-visual materials, teaching aids, and curriculum assistance on such topics as fish behavior, ecology, habitat requirements, hands-on learning activities, fish identification, fish farming, and fisheries management concepts.

In response to this need, the Ministry of Natural Resources is developing teaching resources which will complement Ministry of Education curriculum guidelines. A Primary/Junior and an Intermediate/Senior writing team are currently preparing teaching materials which are expected to include lesson plans, videos, posters, and other resources on a range of fish topics. The school package should be available to schools throughout the province during the 1990/91 school year.

Will these resources be useful to the average teacher? That all depends on you. This newsletter contains activities and ideas to get you started now. Use them to develop a fisheries activity centre in your classroom. How well do they work? What could we have done to make them more useful? What topics would you like to see in the future? Let us know by filling in and returning the enclosed card.

it's catching on

Life at the Bottom of a Lake

Objectives:

Students will be able to 1) describe the living and non-living components of an aquatic ecosystem, and 2) name several fish that live in their part of Ontario.

Method:

Students visit a nearby small lake or pond, observe that local ecosystem, then simulate a lake in their own classroom.

Grade Level: K-6

Subjects:

Dramatic Arts, Environmental Studies, Language Arts, Mathematics, Music, Visual Arts

Skills:

Observing Skills Sequence (use of senses, use of instruments, note patterns and relationships, make generalizations), Processing Skills Sequence (measuring, inferring, hypothesizing), Communicating Skills Sequence (oral, visual, movement, make representations, build models), Problem-Solving Skills Sequence (collect and organize information, apply conclusions)

Duration:

One or more field trips, several activity sessions

Group Size: Any

Setting:

A nearby farm or conservation authority pond, a city reservoir, or provincial park lake; classroom

Concepts:

Aquatic ecosystem, interrelationships, living things, non-living things

Key Vocabulary:

Aquatic ecosystem, living things, non-living things, animal life, plant life

Background:

"Don't judge people until you have walked several moons in their moccasins." That's as true for fish as it is for humans. In order to understand a fish, students must place themselves in its environment. How does the world look to a fish? What does a fish feel, hear, and/or smell?

By observing both the physical characteristics of a lake and the living things that surround or live in it, students can answer these questions. For observation purposes, small freshwater lakes or ponds are best. Plan a fact-finding trip during which you challenge students to begin to see the aquatic ecosystem from a fish's point of view.

Fresh water is teeming with living things called organisms. Microscopic plants and animals provide the basis for other forms of life. The plants change the sun's energy into a source of food for microscopic animals. These tiny animals are then eaten by insects and small fish, which are eaten, in turn, by larger fish.

The shallow water along the shore is particularly important to fish. Insect larvae and other tiny organisms live in or on the mud along the shore. These organisms provide food for fish such as trout and bass. Others are eaten by amphibians which are eaten, in turn, by larger trout and bass.

Although you may see only two or three fish species in the lake you study, there are about 175 different types of fish living in Ontario's lakes. Contact the Ministry of Natural Resources district office nearest to the lake you're studying, to find out what's likely to be in it.

The major purpose of this activity is to acquaint students with one local aquatic ecosystem.

Materials:

Hand magnifiers; flat pans; kitchen strainers; a tape recorder; craft materials such as mural paper, winterizing plastic, paints, brushes, scissors, string, glue, crepe paper, egg cartons, cardboard tubes, pipe cleaners, tissue paper, paper plates and cups, fabric scraps, yarns, green plastic garbage bags and other similar items.

Procedure:

1. Pre-field Trip

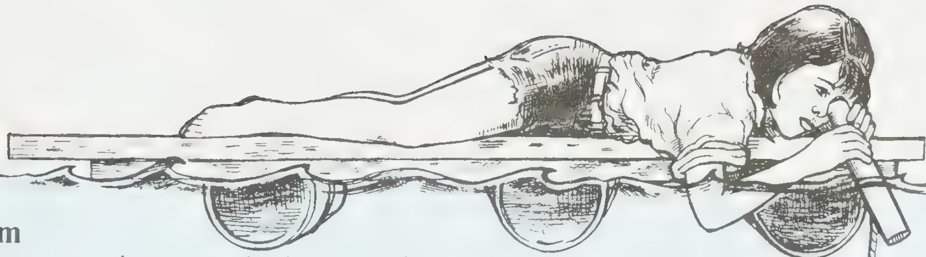
As a class, discuss the following. When students were swimming in a lake or swimming pool, did they ever open their eyes under water? What did the water look like? What color was it? Did the color change according to how deep they swam? What did the bottom look like? What did the top of the water look like from beneath? Was there light shining through the water? How did the light appear? How did things sound? Plan a class trip to a nearby freshwater lake or pond.

2. Field Trip

Challenge the students to observe the lake from the point of view of a fish living in it. Have them listen to and record lake sounds and smells. Describe the shore. Observe the color and form of plant life living in the shallow water. Can students see the bottom? What is it like? Use kitchen strainers to dip into the mud near the shore. Place the material on a flat pan. Search for animal life. Discuss how the plants might influence the animal life present. How might the animal life influence the plants? How might both interact with the fish population? NOTE: If a field trip is impossible, check the availability of films and/or filmstrips on life in a pond.

Build a Reverse Periscope

Plastic wrap secured with an elastic band around one end of a cardboard tube can allow students to see underwater.



3. Classroom

Have students create pictures and other materials that turn their classroom into an underwater world. Here are some activities you may wish to try:

— Observe the way light changes when it filters through a jar of water. What can you do with the windows to make them filter light in a similar way? (Prisms placed on a record player turntable with light playing on them can create the appearance of bubbles around the room. Try covering the windows with winterizing plastic. Have students paint on the plastic in blue and green acrylics. Alternatively, you might paint directly on the windows with tempera paint mixed with soap flakes. To simulate deep water, cover some windows with green plastic garbage bags.)

— Cover the bulletin board and wall areas with mural paper. How can you show the surface of the water? Where is the deepest spot? Where is it the shallowest? Have students create a co-operative mural of how they imagine it appears inside and along the shores of a lake.

— To make aquatic plants, cut, stretch and glue crepe paper to strings. Hang them from the walls and/or ceiling.

— From the ceiling, dangle fish mobiles created by the students. Which kinds of fish form schools near the surface? Which ones live near the bottom? Which ones live in the middle zone? How can students find out?

— Discuss how insects and fish might appear when seen from the bottom looking up. Create insects and fish from this perspective.

— Use boulders, rocks and sand to simulate the lake bottom.

— Interview local anglers regarding the size of fish caught in the lake. Graph the results. Create, to scale, the largest and smallest fish ever caught. What is the average size?

Extensions:

1. Develop a fishy song. Invite another class or parents to visit your classroom. Play appropriate water music, sing the fish song, offer tours of the classroom lake told from a fish's point of view.
2. Write poetry about what it might feel like to be a fish.

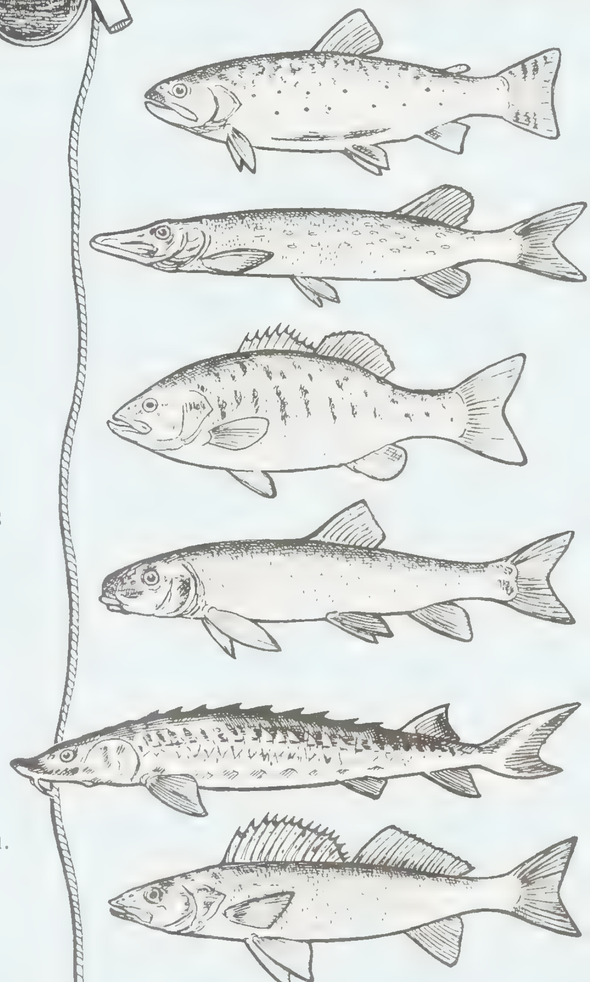
Photo: Courtesy of Helen Mason

3. Have students make hand or finger puppets in the form of various fish or other water creatures. Act out scenes. Insect larvae may be eaten by smaller fish, bigger fish may chase smaller fish, an otter may eat the larger fish, etc.
4. Discuss what animals need to survive underwater. Suggestions should include methods of eating, breathing, moving, reproducing, and surviving predation. Challenge students to create a water creature that will do one of these things extremely well. In what part of the lake will this creature live? What is its name?

Evaluation:

List or draw at least six living and non-living components of an aquatic ecosystem. Show or discuss how they interrelate.
Name several local fish.

Adapted from Entine, Lynn. OUR GREAT LAKES CONNECTION: A CURRICULUM GUIDE FOR GRADES KINDERGARTEN THROUGH 8, Board of Regents of University of Wisconsin, Madison, Wisconsin, 1985.



Can you match these Ontario natives with their names?

ntgrsoeu
sabs
eaeyllw
keip
orttu
rcueks

Did you know?

There are about 175 species of fish in Ontario. This number includes 34 non-native species which now make their home in Ontario. Native fish range in size from tiny one gram shiner minnows to giant 110 kg sturgeon.

Play the Environmental Detective Game

In this game you're a rainbow trout swimming downriver and you have to rate what you see and experience as a benefit or hazard to you and other trout. Give yourself one point for each correct answer, then check your Environmental Detective rating.

Answers on back cover

YOUTH FISHERIES EDUCATION PROGRAM

Primary-Junior

Please help us by filling in and returning this postcard.

1. Did you use any part of the newsletter in your classroom?

YES ___ NO ___

Which part or parts? ______________________________

____

Comments: ______________________________

____

2. What other topics would you like to see in future newsletters?

____

3. How did you receive this newsletter?

____

4. Would you like to be placed on a mailing list for future newsletters?

YES ___ NO ___

Name ______________________________

School ______________________________

Address ______________________________

____

Thank you for helping us improve our primary/ junior newsletter.

it's catching on

Detach Here.

Ministry of Natural Resources Administrative Regions

See over for information on the District Office nearest your school.

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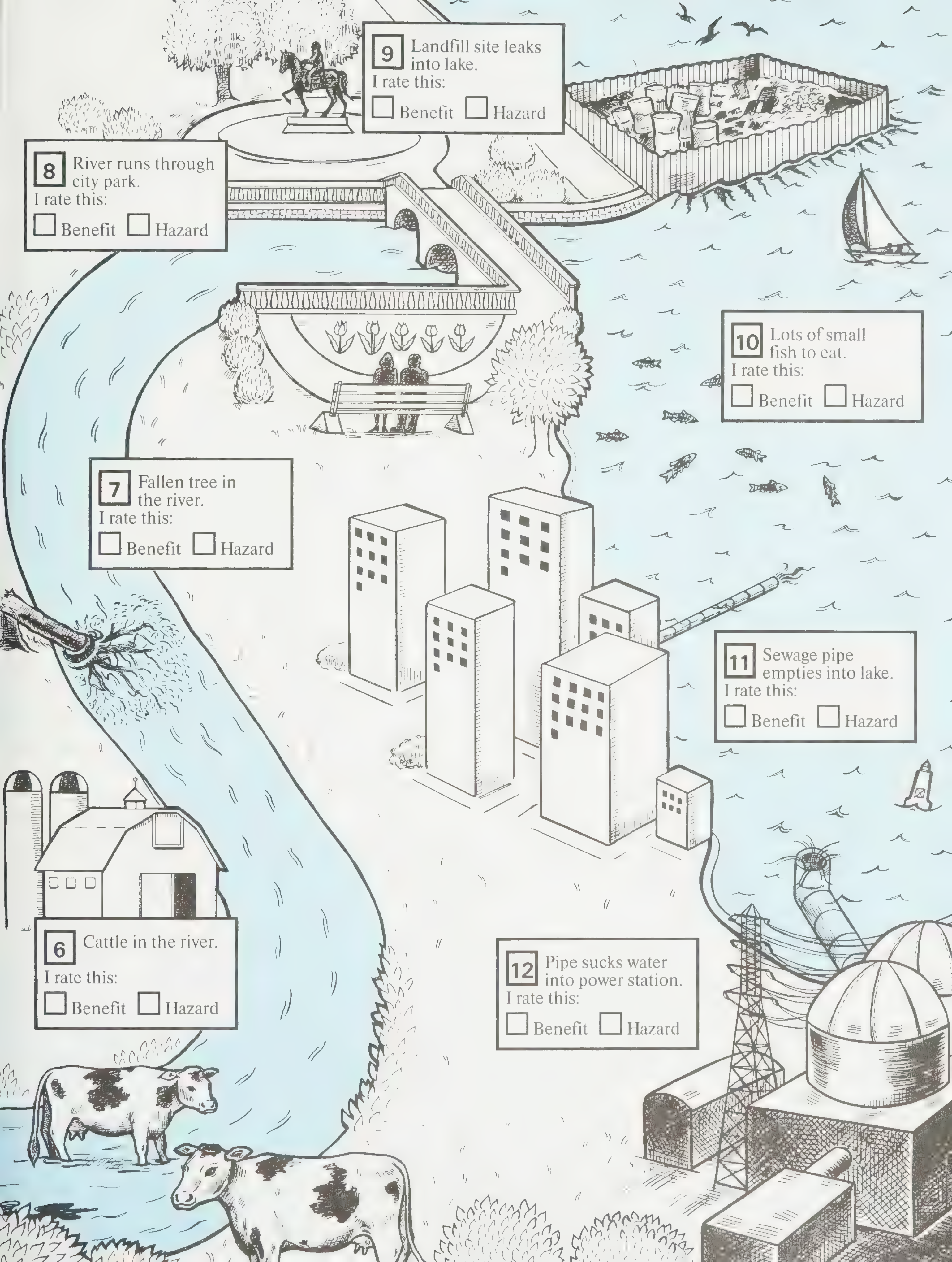

9 Landfill site leaks into lake.
I rate this:
Benefit Hazard
8 River runs through city park.
I rate this:
Benefit Hazard
10 Lots of small fish to eat.
I rate this:
Benefit Hazard
7 Fallen tree in the river.
I rate this:
Benefit Hazard
11 Sewage pipe empties into lake.
I rate this:
Benefit Hazard
6 Cattle in the river.
I rate this:
Benefit Hazard
12 Pipe sucks water into power station.
I rate this:
Benefit Hazard

Meet A Fish

Objectives:

Students will be able to recognize that 1) there are physical differences between species of fish, and 2) different species behave differently.

Method:

By watching fish in an aquarium, students will observe that fish species have physical differences. They also behave in different ways.

Grade Level: K-6

Subjects:

Environmental Studies, Language Arts, Science, Visual Arts

Skills:

Observing Skills Sequence (use of senses, use of measuring devices, note patterns and relationships, make generalizations), Processing Skills Sequence (comparing, measuring, inferring, hypothesizing), Communicating Skills Sequence (oral, visual, manipulation), Problem-Solving Skills Sequence (make plan, collect and organize information)

Duration:

At least three activity periods

Group Size: Any

Setting: Indoors

Concepts:

Adaptation, camouflage, habitat, predation

Key Vocabulary:

Names of tropical fish species, names of several local Ontario fish species

Background:

Fish species can be differentiated using their color, shape, and markings. Color often relates to the specific area where a fish lives. Usually, fish blend in with their surroundings. This protects them from predation. The speckled colors of Ontario's brook trout intermix with the leaves and gravel on the bottom of the streams they inhabit. Bass's greenish-grey shades blend in with the weedy areas where they live.

Fish shape tells something about feeding patterns and the characteristics of the habitat in which it lives. The long narrow lines of northern pike and muskellunge suggest their predatory nature; they are built for speed and quick attack. Fish living in weedy areas are usually short in length and have deep bodies. These physical characteristics allow them to make short quick turns.

Mouth adaptations can also suggest feeding patterns. Suckers feed on bottom-living creatures in shallow water. Lake trout and rainbow trout are predators. How do their mouths, jaws and teeth differ? Study the brown bullhead and channel catfish. What suggests that these are bottom feeders?

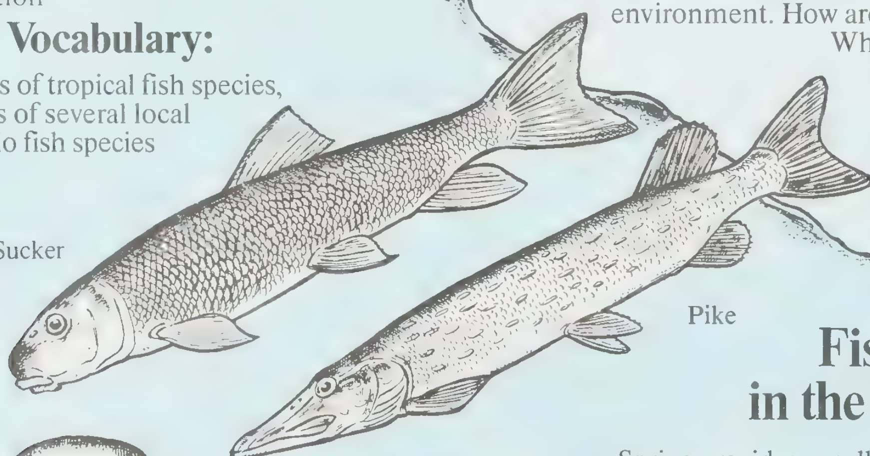
The major purpose of this activity is to acquaint students with the fact that fish species differ both in their physical appearance and in their behavior.

Materials:

Aquarium, aquarium heater, air pump, gravel, suitable plants, tropical fish, tropical fish food.

Procedure:

1. Help the class to plan and set up a fish aquarium. Visit a local pet store to purchase suitable fish. (Guppies, sword tails, and an algae-eating species would work well.)
2. Over several days, observe these fish within their aquarium environment. How are the fish the same? How are they different? What part of the aquarium does each species prefer? Where do they go when someone approaches the aquarium?
3. List questions students have about fish from observing these tropical specimens. Discuss how they can find answers to these questions.



Sucker

Pike

Sucker Mouth

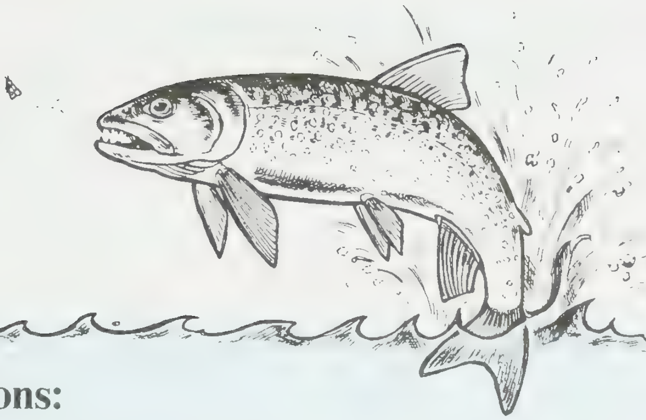
Pike Mouth

Fish in the Wild

Spring provides excellent opportunities for students to see fish in their natural environment. Phone your local Ministry of Natural Resources district office for the timing and location of rainbow trout, smelt, sucker, and yellow pickerel spawning runs. During the fall, ask for information about brook trout, herring, lake trout, rainbow trout, and salmon spawning in your locality. Keep in mind that fish spawning needs are specific and not widely distributed. Be sure to make inquiries well in advance of any planned activity.

How Old Are You?

Tree Cross-section



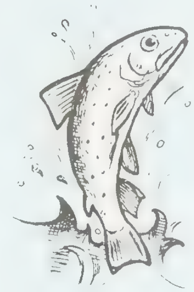
Sing a Fish

Use some of the puppets developed in "Life At The Bottom Of The Lake" to dramatize this song. Sing to the tune of "On The First Day of Christmas".

On the **first** day of summer my muskie brought to me
Some algae to put in my tea.

2 duckweed plants

3 fish larvae



4 fingerlings

5 caddisflies

6 shiners swimming

7 darters darting

8 brook trout leaping

9 catfish splashing

10 walleye diving

11 pike a-dancing

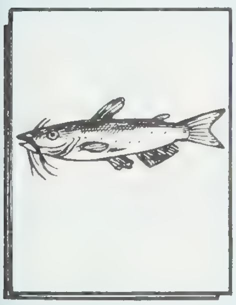
12 lake trout chasing

Extensions:

1. Relate what students have learned to information about Ontario fish species. Using a copy of the "Fish Of Ontario" poster, compare local fish to tropical fish. Why are so many Ontario fish green? (Discuss the color of their habitat. What might a predator see as it looks down into the water?) Note the size of several Ontario fish. Using weights and scales, find something in the room that is the same weight.
2. At least some of our feelings about fish come from the expressions in which we use fishy terms. Discuss the meaning of the following phrases: "That story sounds fishy to me." "They're just small fry." "Now that's a pretty kettle of fish." Draw a cartoon illustrating the literal meaning of each phrase. Draw its actual meaning. In a third cartoon, show the phrase from the fish's point of view.
3. Have students develop a 'My Favorite Ontario Fish' advertising campaign. This can be done by working co-operatively or in groups to produce advertising posters, radio scripts, or even a video broadcast.

Evaluation:

List four ways that fish species differ. Create a new fish species; discuss how its shape, color and mouth adaptations relate to its food and habitat.



Fish Games

A PAIR OF FISH: Students cut the fish from two "Fish of Ontario" posters. Each fish is mounted on stiff cardboard. Cards are placed, face down, on a flat surface. One at a time, students turn over two cards. If the pair match, the student keeps the pair and takes another turn. If the pair does not match, it's the next student's turn. At the end of the game, the student with the most pairs wins. Two to four players.

SCRAMBLED FISH: (For primary students.) Cards are prepared as in A Pair of Fish except that each card is then cut in half. Students work together to match each fish to its other half. Non-competitive.

TELL ME WHEN YOUR BIRTHDAY COMES. (For gifted students.) The object of the game is to be the first player to get a set of cards naming fish that spawn in each of seven different months. Using spawning information from the "Fish Of Ontario" poster, students list the fish that spawn in each month. (Ignore the species that have spawning information according to season only.) Students make six hand-drawn facsimiles of each of these fish. Each fish is mounted either on a blank playing card or on a small index card. Students then make a spinner listing the months of the year. They take turns spinning the spinner. Those who hit a month in which fish spawn may choose a card naming one of the fish that spawn in that month. Students who hit a month in which fish do not spawn may try to negotiate with another player in an effort to trade a duplicate card for one which they need. Three to five players.

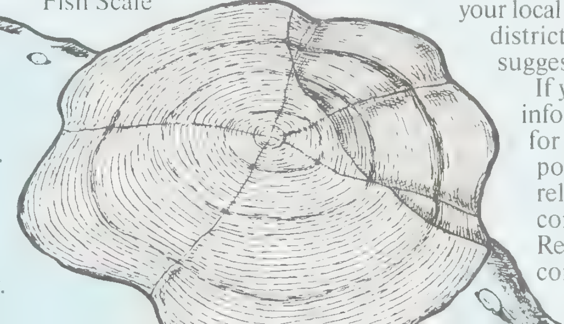
Fish in the Classroom

Unless you have written permission from your local Ministry of Natural Resources district office, it is illegal to keep most Ontario fish species in your classroom. If you prefer observing native species, you may legally obtain bait fish from a baitfish dealer. Before doing this, however, consider the drawbacks. Bait fish aren't good pets. They may survive for only two to three weeks. Not only do they require temperatures lower than those found in most classrooms (16.7 degrees C./62 degrees F.), they're prone to diseases which cannot be easily treated. In addition, you can't return bait fish to the wild without written permission from your local Ministry of Natural Resources district office. That's why we've suggested observing tropical fish.

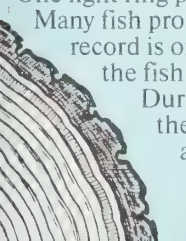
If you would like further information about the regulations for catching, transporting, possessing, culturing, and releasing native fish species, contact the Ministry of Natural Resources district office most convenient to your school.

As a tree grows, it leaves a record of its life. If you look at the cross-section of a tree trunk after a tree has been cut down, you will see a series of concentric rings. You can tell the age of a tree by counting these rings. One light ring plus one dark ring equals one year.

Many fish produce similar records of their age. This record is on their scales. During the winter, when the fish grows slowly, the rings are close together. During the summer, when growth speeds up, the rings are wider apart. You can tell the age of a fish by counting the series of rings. One wide-apart section plus one close-together section equals one year.

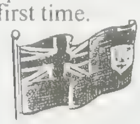
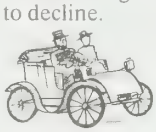
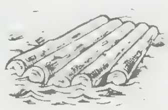


Fish Scale



If I Could See What You've Seen

The sturgeon is both the largest and longest-lived fish in Ontario. A record specimen was caught in Lake Huron in 1982. The fish weighed 110 kg (243 lb.) and was 155 years old. Imagine what changes that sturgeon must have seen during its lifetime!

	Year	Age	
	1827		A sturgeon is hatched.
The sturgeon spawns for the first time.	1847	20	
	1857	30	Ottawa becomes Canada's capital.
	1867	40	Canada becomes a nation.
CPR railway reaches the Sault.	1887	60	
	1892	65	Sturgeon numbers begin to decline.
220 motor cars are registered in Canada. Ontario has 150 Game Wardens.	1903	76	
	1903	76	First airplane flight by Wright Brothers.
Heavy logging has depleted pine stands in the Parry Sound District along Georgian Bay.	1920	93	
	1937	110	First cartoon, "Snow White" by Walt Disney.
First rock 'n' roll record, "Rock Around the Clock" by Bill Haley.	1954	127	
	1967	140	Canada celebrates its 100th birthday.
The first person walks on the moon.	1969	142	
	1976	149	Olympic Summer Games held in Montreal.
	1980	153	Terry Fox starts his cross-Canada run.
The sturgeon is caught in Lake Huron 22 km northwest of Sarnia.	1982	155	

Environmental Detective Game Answers

1. Benefit: fish eggs and young fish can freeze or cook if the stream temperature is too cold or too hot but 13°C/55°F is just right. 2. Benefit. 3. Hazard: even the smallest amounts of some chemicals can be deadly to fish. 4. Hazard: it is difficult for fish to breathe in oily water. 5. Benefit: overhanging bushes attract insects for fish to eat. 6. Hazard: cattle can stir up the stream bottom and pollute the water. 7. Benefit: the tree provides cover and allows the river to gouge out deep pools where fish can rest and hide. 8. Hazard: no resting places for fish and no vegetation on the banks to provide shade from the sun. The river may become too warm. 9. Hazard: see 3. 10. Benefit: big fish like to eat small fish. 11. Hazard: especially if the machinery in the sewage treatment plant fails to operate properly. 12. Hazard: your chances of coming across this intake pipe in a large lake are few. But many small fish do get sucked in every day.

Environmental Detective Rating

8-12: Sherlock Holmes would be proud!
4- 7: Even good detectives miss a clue or two.
0- 3: Better polish your magnifying glass!

Fish Parenting Styles Differ Between Species

NO PARENT – Northern pike spawn in early spring. Their eggs are scattered over weedy shallow bays or flooded areas. There, they stick to the bottom or to vegetation. Although the eggs are deserted by both parents, the young can survive without them.
SINGLE PARENT – Largemouth bass and smallmouth bass lay their eggs in a shallow bowl they scoop out of the sand. The male stands guard until the young are one-to two-weeks old.
BOTH PARENTS – Brown bullheads make their nests along banks or among tree roots. After hatching, the young fish stay very close together. One or both parents babysit the young until they are 5 cm long.

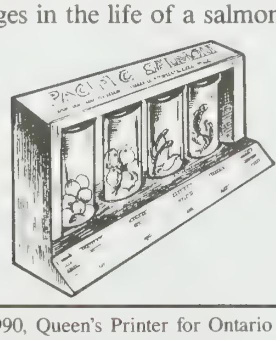
Community Helpers

"The Ministry of Natural Resources are the people to thank for all the lovely fishing," writes student John Kock in an essay that won him first prize in Wingham District's 'The Importance Of Fish As A Resource' contest. Yes, fish do contribute to Ontario's economy. Many airplane pilots, baitfish dealers, boat builders, commercial harvesters, engineers, fish farmers, guides, motel owners, net makers, culture station technicians, restaurant owners, tackle producers, and yes, even writers, owe at least part of their income to fish.

But the most visible "fish" community helpers are Ontario's Conservation Officers. The CO's uniform is a familiar sight on many lakes and streams. That's because Ontario's COs do more than supply information on fish and fishing. They also help improve the aquatic environment, and make sure that people obey fishing regulations and laws. How many fish-related jobs exist in your community?

Resources

- "Fish Of Ontario." Full color bilingual poster. Available from the Ministry of Natural Resources. Contact either your local district office or The Public Information Centre, Ministry of Natural Resources, Room 1640, Whitney Block, 99 Wellesley Street West, Toronto, Ont., M7A 1W3. Telephone (416) 965-7883.
- Leslie M. Frost Natural Resources Centre, Dorset, Ontario. Situated east of Huntsville on Highway 35, this outdoor education residential centre offers fish-related programs for students from Grades 6 to OAC. There are also numerous professional development workshops available to teachers. For details, write to The Director, Leslie M. Frost Natural Resources Centre, Ministry of Natural Resources, Dorset, Ont., P0A 1E0. Attention: Barrie Martin. Telephone (705) 766-2451.
- "Gone Fishing — Fish Going." Full color poster in English only. Free from the Ministry of the Environment. Contact either your local district office or Public Information, Ministry of Environment, 135 St. Clair Avenue West, Toronto, Ont., M4V 1P5. Telephone (416) 323-4321.
- "Egg To Fry Display." A wooden display rack with four glass vials containing salmon at different stages in early development. Catalogue #S50 from British Columbia Teachers' Federation Lesson Aids, 105-2235 Burrard Street, Vancouver, B.C., V6J 3N9. Telephone (604) 731-8121. $12 prepaid.
- Salmon Posters. Color. Set of eight. 45 cm by 55 cm. Seven posters showing various stages in the life of a salmon. The eighth poster shows the size of the early stages in proportion to the adult. English words could easily be covered with French. Catalogue #S35A from British Columbia Teachers' Federation Lesson Aids. See above. $12 prepaid.



- Fisheries Education Information. If you would like further assistance, contact the Fisheries Education Specialist, Ministry of Natural Resources, Room 3440, Fisheries Branch, Whitney Block, 99 Wellesley Street West, Toronto, Ont., M7A 1W3. Telephone (416) 965-7885

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Ministry of Natural Resources

YOUTH FISHERIES EDUCATION PROGRAM

SPACE INVADERS REACH ONTARIO

No, Ontario's lakes and streams are not filling up with old video games. Some of the space within Ontario waters, however, has been invaded by a long line of introduced species. Let loose by accident or design, they now make their homes here. This newsletter is all about these invaders. How did they get here? What impact have they had? Have they helped or harmed the aquatic environment? Is there such a thing as a "good" introduction? The latest invader, the zebra mussel, receives special attention. Explosive in its colonization of the Great Lakes, these tiny mussels provide an ongoing case study of how introduced species arrive in a new environment, why they succeed, and how they alter the ecological balance. Included are two new zebra mussel activities, and many lesson ideas that make the topic of aquatic introductions come alive.

TEACHING RESOURCES NEARING COMPLETION

The Ministry's latest set of resource education manuals, Fish Ways, will take its place alongside Project WILD and Focus on Forests in October of 1991. A two-manual format allows students of both elementary and secondary age to discover Ontario's fisheries resource through appropriately graded games, experiments, simulations, role plays, field investigations and other active learning methods. Although directly linked to the school curriculum, many of Fish Ways' discovery-based opportunities are well-suited to Scouts, Guides and other groups dealing with resource education. A three-ring binder holds each manual, as well as a full-colour fish poster and a set of fish cards. For more information on Fish Ways, turn to the back cover of this newsletter.

FISH ways

INTRODUCED SPECIES

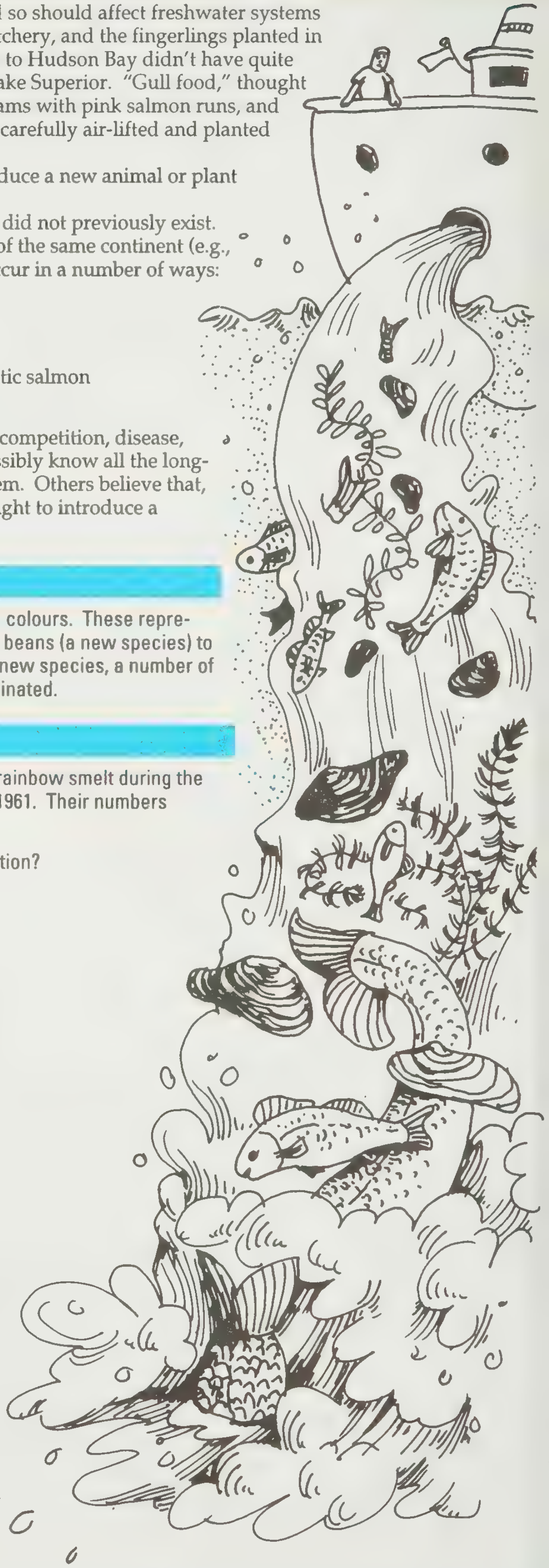
In 1954, MNR fisheries biologists determined that the Hudson/James Bay drainage basin would provide excellent habitat for West Coast salmon. These biologists also decided that, of all the salmon, pink salmon were the best choice for introduction into this basin. They spend the least amount of time in fresh water, and so should affect freshwater systems the least. Eggs were collected in British Columbia, incubated in the Thunder Bay hatchery, and the fingerlings planted in a tributary running into Hudson Bay. Since the last plane to transport the young fish to Hudson Bay didn't have quite enough room, about 21,000 fish were flushed into the Current River, a tributary of Lake Superior. "Gull food," thought hatchery staff. Instead, these fish lived and reproduced, eventually filling some streams with pink salmon runs, and spreading to every other Great Lake. On the other hand, the fish which had been so carefully air-lifted and planted in the Hudson Bay area, failed to reproduce.

The irony is instructive: you can never be sure what will happen when you introduce a new animal or plant species.

The term 'introduction' refers to releasing a species into an environment where it did not previously exist. Introductions may come from another continent (e.g., zebra mussel), different parts of the same continent (e.g., rainbow smelt), or even the next lake over (e.g., northern pike). Introductions can occur in a number of ways:

1. Authorized: coho and chinook salmon
2. Unauthorized but purposeful: rusty crayfish
3. Accidental: zebra mussel
4. Reintroduction (of species that have disappeared from the environment): Atlantic salmon
5. Accidental through opening a transportation corridor: white perch

Authorized or not, introductions can disrupt aquatic systems through predation, competition, disease, or interbreeding with native species. Some people believe that, because we can't possibly know all the long-term effects that any introduction will have, they have no place in an ecological system. Others believe that, if the introduction is carefully planned, and the projected effect is beneficial, it's all right to introduce a species.



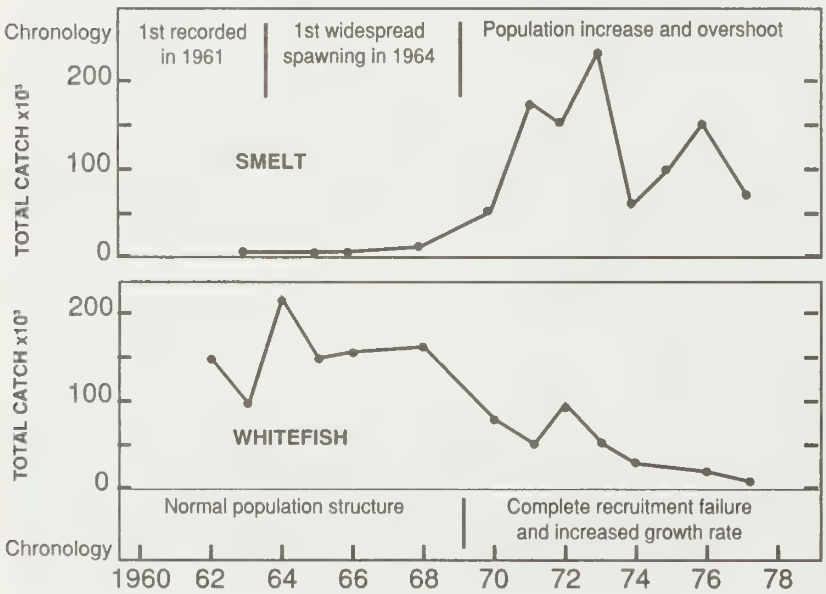
Primary/Junior

Fill a large jar right to the top with a variety of marbles and/or beans of different sizes and colours. These represent a balanced, natural aquatic community. Challenge students to add a number of lima beans (a new species) to the jar. Experiment with a variety of solutions. Discuss how, in order to make room for a new species, a number of other individuals (marbles) or species (were all marbles of one colour removed?) are eliminated.

Intermediate/Senior

The two graphs show changes in the estimated total angling catch of lake whitefish and rainbow smelt during the 75-day Lake Simcoe ice fishing season. Rainbow smelt first appeared in Lake Simcoe in 1961. Their numbers peaked in 1974.

How did the introduced rainbow smelt population impact the native lake whitefish population?



Changes in the estimated total angling catch of lake whitefish and rainbow smelt during the 75 day Lake Simcoe ice fishing season.

INTRODUCTIONS: CURE OR CONUNDRUM?

Are there times when it's permissible to introduce a species? Thirty years ago, most fisheries biologists would have answered, "yes." But the more they learned about how species interact with one another, the more they realized how limited their knowledge really is. As a result, today's biologists are hesitant about giving a definitive answer to such a question. Instead, they admit that there are a lot of grey areas.

Brook trout, for example, is a native Ontario species that favours streams and lakes with clear, cool (below 20 C), well-oxygenated waters. With deforestation and development, less water was absorbed into the water table. This reduced the amount of ground water discharges, which control the minimum flow of streams and moderate their temperatures. As a result, many streams in southern Ontario silted in and warmed up, making them un-inhabitable by brook trout.

Because of this brook trout loss, and because European immigrants wanted a familiar fish, biologists as early as 1913 began planting brown trout in streams previously inhabited by brook trout. Native to northern Europe, brown trout share much the same habitat as brook trout, but are more successful in warmer water. In streams with limited headwaters, brown trout also can dominate by preying on brook trout fry. In streams with extensive headwaters, however, brook trout fry can find enough habitat in which to hide, allowing the two species to coexist.

Planting brown trout met the human need for a familiar species in Ontario streams. Brown trout provided a challenging fishery where one no longer existed, but they restricted the brook trout still further. In addition, does their presence distract people from trying to solve the real question of habitat degradation?

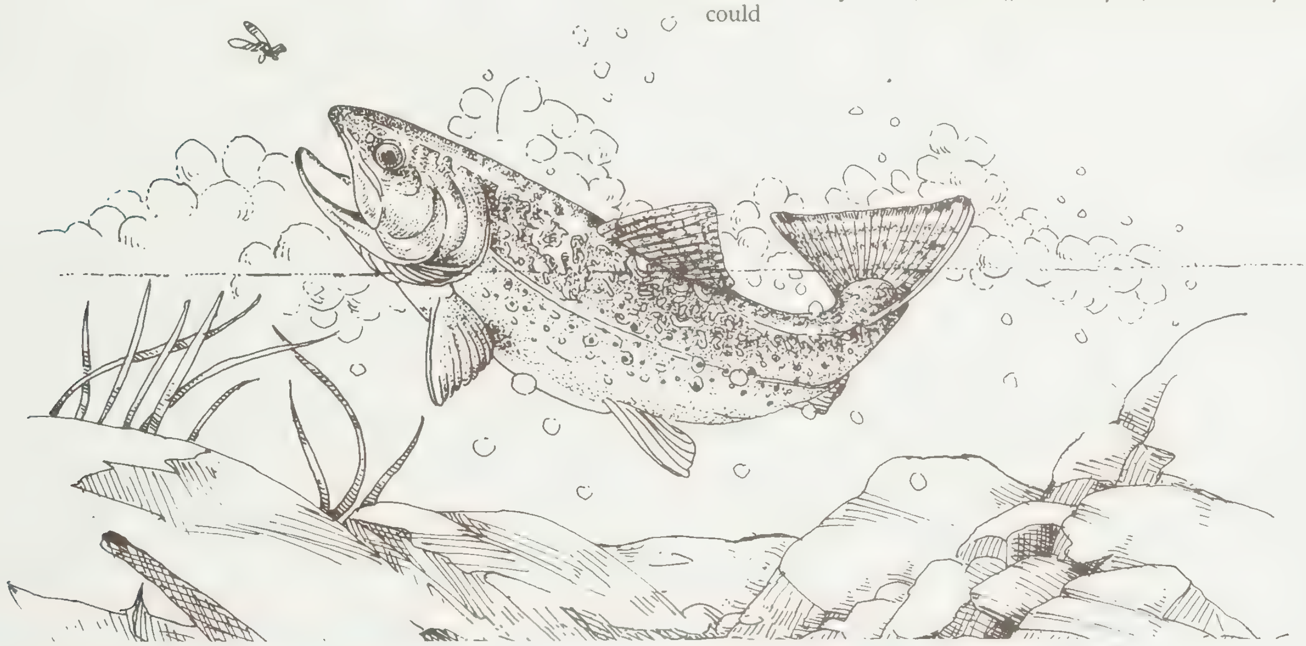
If southern Ontario's streams were rehabilitated, they could maintain a larger population of native brook trout. On the other hand, because of the extent of deforestation added to the amount of agricultural, industrial and urban land use, it would be very expensive, if not impossible, to restore all former brook trout streams. Brown trout, which is a top level predator, controls other species, thus maintaining the aquatic community balance in a similar way to brook trout. Is total rehabilitation worth the cost? Are brown trout an acceptable compromise, in either the short- or long-term?

Primary/Junior

Take a second look at your marble jar. Remove the lima beans from the previous activity, as well as all but a few of one colour marble or bean. Indicate that people's actions have changed conditions, and all but eliminated one popular species. They can add another (the limas), but if they do, scientists say there's one chance in four that the reduced species will disappear, as well as one other species (that is, if you flip two coins, these things will happen only if two heads result). If they choose to add the limas, flip the coins. **But**... after flipping, state that it turns out to be a three in four chance. Remove the other marbles or beans if the coins show two heads, or a head and a tail.

Intermediate/Senior

Debate or discuss: Because it is virtually impossible to fully restore southern Ontario's stream habitat, it is wise to introduce brown trout as the next best alternative.



STUDENTS HELP PLANT FISH

Students in four classrooms of the Scarborough Board of Education will help plant about 20,000 brown trout from Harwood Fish Culture Station into the Rouge River this spring, marking a continuing improvement in habitat quality. The program is part of an ongoing urban fisheries initiative sponsored by the Maple District Office of the Ontario Ministry of Natural Resources.

"Teaching about fish is an ideal way to teach about water quality," states Bill Clemens, a teacher of Environmental Studies at Dr. Norman Bethune Collegiate, and one of the field testers for the Intermediate/Senior Fish Ways Manual. "Once kids have worked in watersheds, they know why they shouldn't be putting things down the drain."

During the experimental program, high school students from Clemens' classes will help elementary level pupils who are learning about fish needs and habitat requirements. "We'll be encouraging observation and experiential learning." Clemens is enthusiastic about using such hands-on experiences to help students learn.

BRINGING BACK NATIVE SPECIES: RE-INTRODUCTIONS

There's an ecological argument that the species that evolved in an area are best adapted to that environment and, if now missing, should be returned if habitat conditions are appropriate. This is the philosophy that the Ministry of Natural Resources is following in reintroducing Atlantic salmon to the Great Lakes.

Before the arrival of white settlers, Lake Ontario teemed with a population of Atlantic salmon that had been landlocked after the Champlain Sea receded around 8,000 years ago. Due to a series of problems that included habitat degradation and over-harvesting, these salmon were extirpated (eliminated from this part of their range) by the turn of the century.

In the past ninety years, Ontario citizens have become a lot more interested in habitat protection. In addition, many of the streams along the north shore of Lake Ontario where these fish traditionally spawned have been rehabilitated. As a result, the Ontario Ministry of Natural Resources is attempting to re-establish Atlantic salmon.

Unfortunately, the genetic stock of the original Lake Ontario Atlantic salmon disappeared around 1898. To replace it, the Ministry of Natural Resources collected a variety of eggs from Nova Scotia Atlantic salmon that spend part of their lives in the ocean, and Atlantic salmon from Maine that spend all of their lives in fresh water. Using both of these stocks, staff planted one-year-old fish in the Credit River and Wilmot Creek in the springs of 1988, 1989, and 1990. By 1990, the Credit River sported its first mature Atlantic salmon. Unconfirmed sightings were made in Wilmot Creek.

Will naturally reproducing Atlantic salmon return to Lake Ontario? Although the habitat is there, Lake Ontario also has populations of brown and rainbow trout and Pacific salmons, all introduced species which weren't there when Atlantic salmon originally inhabited the lake. These introduced species have similar requirements and use the same habitat as Atlantic salmon. Biologists aren't sure how the fish will interact, or how Atlantic salmon will compete with some of these non-native fish that now use Lake Ontario streams for spawning. Finding out will take time.

Primary/Junior

Take a third look at your marble jar, filled again to the top. Have the lima beans in the jar represent introduced species that are using the habitat that once was used by Atlantic salmon. Challenge students to come up with ways to remove the limas without "harming" the rest of the contents. Take out some limas and add some Atlantic salmon with each reasonable suggestion (e.g., fishing contests for only those species, netting and removing unwanted species during spawning runs).

Intermediate/Senior

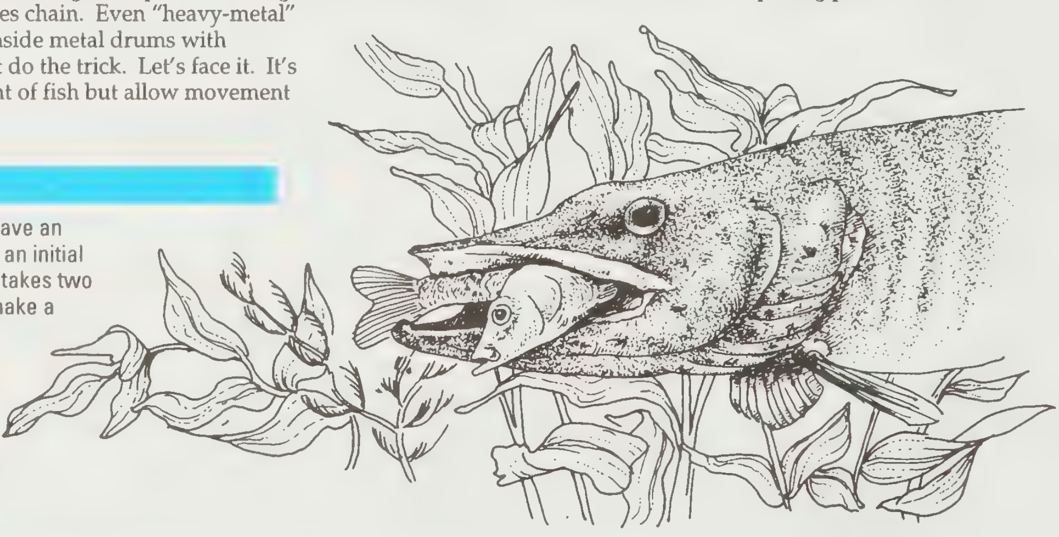
Discuss: What is good for the environment? Does this become a question of what is good for you and what is good for me? Should it?

SHOW-DOWN IN THE KAWARTHAS

Letting a "native" species move into new waters can also be a problem.Throughout North America, wherever northern pike have entered an area where muskellunge previously existed alone, the pike have always come out on top. Though it has been suggested several times, there is as yet no evidence that young pike eat young muskellunge. Pike spawn first, however, just as the ice goes out. Hatching later, young muskie must compete with two-week old pike ravenous for another meal. In addition, young pike seem to be more aggressive, less fussy eaters, better converters of protein, and faster growers than young muskellunge.

Only where pike and muskellunge spawn in separate locations, as in many parts of the Great Lakes, or in large spawning areas where the young are not concentrated together, can muskie hold their own. That's why anglers are so concerned about the Kawartha Lakes where the connecting canals of the Trent-Severn Waterway are allowing pike into muskellunge territory.

The Ministry of Natural Resources has not given up without a fight; but so far, staff have been unsuccessful in repelling pike from the liftlocks leading into the Kawartha Lakes chain. Even "heavy-metal" music created by striking steel plates inside metal drums with mechanically operated hammers didn't do the trick. Let's face it. It's almost impossible to prevent movement of fish but allow movement of boats.



Primary/Junior

Have a pike versus muskie tug-of-war. Have an equal number of fish, but since pike have an initial size advantage due to earlier hatching, it takes two children to make a pike, but only one to make a muskellunge. Discuss the results.

Intermediate/Senior

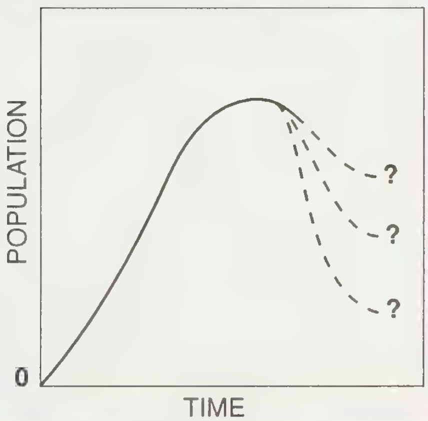
Interview anglers, members of outdoor clubs, and Ministry of Natural Resources staff in your area to find out whether there is a pike/muskellunge problem. Have any muskellunge spots already been lost to pike?

ATTACK OF THE BELL CURVE

Many species are introduced to the environment and don't fit in. These species either die out or maintain such low numbers that they have little or no impact.

Successful introductions follow a definite pattern - that of the familiar "bell curve". The number of individuals multiplies. Numbers rise to a peak, then decline to a somewhat lower level, depending upon predation and the carrying capacity of the individual environment.

Unlike a true bell curve, however, no one can predict when or at what level the peak will occur, or at what level the final balance point will be. At the same time, it's difficult to foresee all of the short-or long-term effects of an introduced species.



Primary/Junior

Plant five 10 cm pots with the following number of lima bean seeds: #1 — two seeds, #2 — 4 seeds, #3 — 8 seeds, #4 — 16 seeds, #5 — 32 seeds. Grow the plants to maturity. What happens? Discuss the term "competition," and how having too many of the same species in a given amount of space may mean that some die or are stunted.

FREE POSTERS

Stop The Invaders is a full-colour poster outlining six introduced species: milfoil, purple loosestrife, ruffe, sea lamprey, spiny water flea, and zebra mussel. Write to Public Information Office, Great Lakes Indian Fish and Wildlife Commission, P.O. Box 9, Odanah, Wisconsin, 54861.
Single copies are free.

Zebra mussel posters can be obtained from your nearest MNR district office. Ask about any additional information.

Intermediate/Senior

Assuming that pink salmon eggs had a survival rate of 1 per cent, and that 1 per cent of the fingerlings released into Lake Superior survived to spawn, plot the growth of the pink salmon population over a period of six years. (Most pink salmon spawn as two-year-olds and die soon afterwards). To get you started, here are the calculations for the first 3 years:

	Year		
	1	2	3
1. Beginning population	2,100*	15,750	15,750
2. Number of two-year-olds	2,100	0	15,750
3. Females (#2 divided by 2)	1,050	0	7,875
4. Offspring (#3 x 1500 eggs per female x .01 survival rate)	15,750	0	118,125
5. Total population	15,750	15,750	118,125

* 21,000 x .01 survival rate

What factors will prevent the population from continuing to expand at this rate?

LAWS SET TO PROTECT FISH

Surprising as it may seem, pink salmon were not the only fish that were supposed to die — but didn't. Goldfish released by their owners into local streams and ponds have reproduced and can now be found at least as far north as Timmins. Goldfish flushed down the toilet may also reach the wild by way of some sewage settling ponds. In the early seventies, piranha, a species native to South America, were found in western Lake Erie. They must have arrived via someone's aquarium. Fish native to the United States and often used as bait have also been found in pockets of Ontario. About fifteen years ago, an illegal immigrant appeared near Ottawa. It was a margined madtom, a small member of the catfish family that someone must have snuck across the border and then released. In another case, river chub native to southwestern Ontario appeared in the Madawaska River west of Pembroke. How did they get there? Possibly via an angler who dumped them at the end of a day's fishing.

The truth is that most of these fish were probably introduced by ordinary citizens ignorant of Ontario's Sport Fishing Regulations. In fact, in Ontario, it is against the law to release any live fish into a body of water unless it was taken out of that body of water, or to transfer live bait across the border. Although it may seem a waste, at the end of a day's fishing, baitfish must either be returned to the place where they were caught, or killed and buried a good distance from the nearest body of water.

What about aquarium fish? That's something you should consider before acquiring them. Are you willing to maintain the fish in appropriate conditions for their entire life span? If not, it may be unfair to pass the responsibility on to someone else. Either kill them by hitting them sharply on the head with a small stick or return them to the store where you bought them.

Why such a concern about non-native fish? In addition to adding competing species, introduced fish can spread disease to native species. Fish suffer from a variety of diseases caused by bacteria, fungi, parasites, and viruses. Just as the common cold virus is everywhere, many disease agents are present and changing all the time.

Primary/Junior

You have to move to New Zealand and can't take your goldfish. However, your friends and even the pet shop refuse to give it a home. Dramatize the situation. What do you do?

Intermediate/Senior

Map the places of origin and spread of some non-native species that have been found in Ontario (see centre table). Discuss the ways those species could have arrived from their native habitats.

SOME AQUATIC SPECIES INTRODUCED TO ONTARIO WATERS

ALEWIFE

Place of origin:
Atlantic coast

First reported in Ontario:
Lake Ontario, 1873

Current Distribution and Status:
all Great Lakes; naturalized[1]

How they arrived:
into Lake Ontario, varying opinions; possibly:
- arrived when the area was part of an ocean about 8,000 years ago
- planted accidentally with some American shad about 1870
- migrated through water routes, including canals in New York State, or up the St. Lawrence River
- moved into upper Great Lake system through the Welland and/or Erie barge canal before 1931.

Effects:
negative:
large numbers can clog municipal and industrial intake pipes

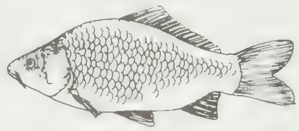
die-offs of large numbers can foul beaches during spring and summer months

concentrate toxins they pass on to predator fish

positive:
provide food for native and introduced species of predacious fishes

Controls:
artificial: none
natural: water depth (need deep water to overwinter) and temperature (moderate range) needs may naturally limit range; predators

COMMON CARP



Place of origin:
Orient via Europe where introduced in 1227

First Reported in Ontario:
Ponds near Cedar Grove, Ontario, 1880

Current Distribution and Status:
from the St. Lawrence River to Lake Superior and in many inland lakes; naturalized[1]

How they arrived:
introduced for aquaculture during the late 1800s; escaped from rearing ponds.

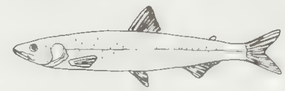
Effects:
negative:
adult fish damage the nests and eggs of other fish species

They tear up the vegetation in shallow waters, changing the plant community composition and decreasing water clarity

by affecting habitat, they have displaced bass from native spawning beds

Controls:
artificial: none
natural: difficult — carp are adaptable and resistant to pollution; lack of suitable habitat; interbreeding with goldfish produces sterile offspring

RAINBOW SMELT



Place of origin:
Atlantic coast; landlocked population in Eastern Ontario

First Reported in Ontario:
Lake Huron in 1925

Current Distribution and Status:
Great Lakes watershed and many inland lakes; naturalized[1]; now so prolific that seven to eight million kg are commercially harvested from Lake Erie annually.

How they arrived:
- introduced into Crystal Lake in Michigan, 1912, and spread by bait bucket and downstream migration to upper Great Lakes
- entered Lake Ontario through Erie Canal.

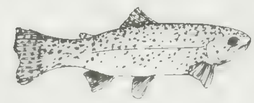
Effects:
negative:
young may compete for habitat with young whitefish

young may eat fry of lake trout and whitefish

adults eat larval whitefish

Controls:
artificial: none
natural: predators

RAINBOW TROUT



Place of origin:
Pacific Coast from Mexico to Alaska

First Reported in Ontario:
Great Lakes, late 1800s

Current Distribution and Status:
St. Lawrence River and Great Lakes plus tributary streams, many inland lakes and ponds; naturalized[1], one of top five game fish

How they arrived:
authorized introduction, possibly as early as 1883

Effects:
negative:
dominate the stream environment by out-competing brown and brook trout

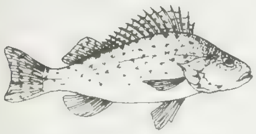
successfully compete at the fry stage because of their large numbers, larger size, and the fact that they are non-territorial, and so can take advantage of all food opportunities

positive:
provide an excellent game fish

Controls:
artificial: fishing, habitat destruction
natural: predators (when small), sea lamprey

Naturalized refers to species that have adapted to a new environment so that they maintain a self-reproducing population.

RUFFE
(pronounced "rough")



Place of origin:
fresh water and brackish water in northern Europe

First Reported in Ontario:
Duluth Harbour, Lake Superior, 1986/7

Current Distribution and Status:
U.S. end of Lake Superior; limited range

How they arrived:
in the ballast water of ocean-going ships

Effects:
negative:
may feed on whitefish eggs and may compete with yellow perch, two species important to the Great Lakes commercial fisheries

young may feed on young trout and salmon, potentially impacting Ontario's sport fishery

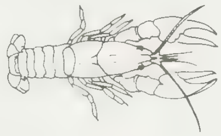
spiny fins discourage bigger fish from eating them

Controls:
American side of Lake Superior (in Duluth Harbour area):
- increase predation by planting northern pike and walleye in the affected area
- limit angling for predator species

On the Canadian side of Lake Superior, no controls are presently in place. Efforts are being made to document any spread of the ruffe by:
- checking ballast water of boats routinely moving from Duluth Harbour to the Canadian side of the lake
- placing sampling nets in or near the slips used by such boats

Effects of control:
- so far, the ruffe is limited to American side of Lake Superior from Duluth to the western Apostle Islands

RUSTY CRAYFISH



Place of origin:
lower Midwest United States

First Reported in Ontario:
isolated lakes in Frontenac, Haliburton, Hastings, Peterborough and Victoria counties, plus one in Kenora District, 1964

Current Distribution and Status: five lakes in south-central Ontario and one in the Kenora area; spreading into nearby rivers

How they arrived:
possibly in the bait buckets of cottagers who brought the crayfish from their native Ohio

Effects:
negative:
replacing native crayfish species

appears to be eating small water plants and, as a result, may affect bass habitat

Controls:
artificial: it is illegal to import live crayfish
natural: limited by cold water temperatures and predation

SPINY WATER FLEA
(a tiny zooplankton that grows to an average length of one cm; also referred to as B.C. plankton)

Place of origin:
northern Europe

First Reported in Ontario:
Lake Huron, 1984

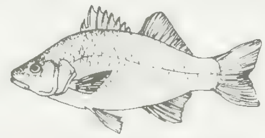
Current Distribution and Status: Great Lakes waters, and some of the Muskoka Lakes; naturalized

How they arrived:
- fresh water or mud in the ballast water of merchant ships

Effects:
negative:
monopolize zooplankton food supply, adversely affecting growth rates and survival of young fish

Controls:
artificial: none
natural: difficult; spines limit predation by fish under five cm. in length; vast reproductive potential

WHITE PERCH



Place of origin:
saltwater areas of the Atlantic coast

First Reported in Ontario:
southeast corner of Lake Ontario, 1950s

Current Distribution and Status:
lakes Ontario, Erie and Huron, Lake Superior (U.S. side); expanding its range

How they arrived:
moved up the Hudson River and via various canal systems into Lake Ontario and Lake Erie

Effects:
negative:
prey on and compete with other fish

suspected to be partially responsible for the decline of Lake Erie's yellow perch population

Controls:
artificial: none
natural: limited by cold water temperatures and predation

Primary/Junior

Create a chart of the species and numbers of the fishes caught by students or their parents within the past year. How many were introduced species? How many were native species? Commonly caught introduced fishes from outside Ontario include chinook, coho and pink salmon, rainbow and brown trout, white bass, white perch, carp, and rainbow smelt. For help with identifying any locally important introduced species not listed here, contact your local MNR district office.

Intermediate/Senior

On a map of the world, locate the country or province where the parents or grandparents of each student were born. Chart the number of relatives who were born locally. Chart the transportation methods the others used to reach the area: boat, plane, car, etc. Map the areas of the world from where varying aquatic species arrived in the Great Lakes. Chart the methods they used: bait bucket, canal, ballast water, etc. Research and add other aquatic species to the chart, or find out more detail about one of the species listed.

ZEBRA MUSSELS

THE LATEST INVADER

How would you react if, on your way to school one morning, you noticed that every hard surface — parked cars, playground equipment, utility poles, etc. — had been covered with live shelled creatures? Zebra mussels, thumbnail-sized, clam-like bivalves, have done that, only underwater. They have invaded the Great Lakes, in some areas covering every solid object in their path.

The zebra mussel originated in the Ponto-Caspian region of Poland, Bulgaria, and Russia. It spread throughout the rest of Europe via boat canals built during the late eighteenth century, and reached Great Britain by the 1830s. It is now in North America.

The phenomenal spread of this tiny mussel is due to several factors, including its fertility, ability to travel, adaptability, and eating habits. Egg production begins when water temperatures reach 12 C. Since female mussels continue to produce eggs until the water cools to below this temperature, a fully mature female can produce over 30,000 eggs per season.

The eggs are fertilized outside the shell. Within a few days, they hatch into free-swimming larvae called "veligers." Invisible to the unaided human eye, these veligers remain suspended in water for at least eight days, and can float on the currents for up to three weeks. Most of the larvae die or are eaten. But enough of them live and attach themselves to firm objects that shoals of adult zebra mussels are created which in turn produce eggs, thus completing and beginning the life cycle.

Zebra mussels generate tiny tufts of hair known as byssal threads which protrude from the hinged section of their shell. These threads have an adhesive secretion used to attach the mussel to any hard surface, including rock, metal, wood, vinyl, glass, rubber, fibreglass, paper, plants, crayfish and other molluscs. Zebra mussels may even colonize soft, muddy bottoms by building up on native clam shells.

Within three weeks of attachment, they transform into the typical, double-shelled mussel shape and mature within the year. Zebra mussels can live from four to six years.

Because of their preference for moderate temperatures, zebra mussels usually occur at depths of two to 14 meters. Veligers are most common at three to seven meters, and seem more sensitive to low temperatures. Both adult and larval zebra mussels are sensitive to low levels of dissolved oxygen, particularly at higher temperatures. They need minimum calcium concentrations of around 10 parts per million for survival and growth.

Primary

While students are doing an art or construction activity that requires a bit of space, begin placing brightly-coloured adhesive dots around the work area. Indicate that these dots are a new kind of animal that is coming into the area. They need space to live, so the students will have to stay about one arm's length from any dot. Slowly add dots until the students are crowded together and unable to work. Ask them how they feel about this "invader" taking their space. Lead into a discussion of zebra mussels, and\or the "Mussel Mania" activity.

Junior to Senior

During the period of May to October, chart the daily water temperatures of a nearby water body, or find out the approximate daily temperatures for the past year. During what period of the year would that water body allow zebra mussels to reproduce? Assuming that females produce about 200 eggs per day, how many eggs could each female produce during that period?

Intermediate/Senior

Zebra mussel densities can easily reach 100,000/m^2. How many eggs would be produced by one m^2 of mussels during that period? If one per cent survived, how many new m^2 of hard surface could they cover at a density of 10,000/m^2?

YOUTH FISHERIES EDUCATION PROGRAM

Please help us by filling in and returning this postcard.

I am a: primary/junior____intermediate/senior____teacher.

1. Did you use any part of the newsletter in your classroom?
   YES _____ NO _____ Which part or parts?
   Comments: ______________________________
   ____
2. What other topics would you like to see in future fisheries education materials? ____________
   ____
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MUSSELS, MUSSELS EVERYWHERE

Trying to find out exactly who brought zebra mussels into Ontario is like trying to trace the name of the student who tracked mud across the main lobby. After considerable detective work, you can estimate approximately when the muddy tracks first appeared; but it's almost impossible to identify the culprit. Researchers first discovered zebra mussels in Lake St. Clair in June 1988. From the evidence, they estimate that the species arrived in the area, probably in the ballast water of one or more ocean-going freighters, sometime during either 1985 or 1986. When the freighter took on its homeward-bound load, it unloaded its extra ballast water — and the rest is history.

Ironically, the zebra mussel invasion may have been precipitated by an environmental clean-up. During the past 10 to 15 years, Europeans have been improving the water quality in their major harbours and estuaries. This increased the amount of zebra mussel habitat, and increased the chances of picking them up in ballast water. Over the same period, North Americans have been working to clean up the Great Lakes. The fact that we improved the environment after some native plants and animals had been eliminated or greatly reduced in number helped to unbalance the system, and open the way for introduced species.

In fact, much of lakes St. Clair and Erie, as well as the shallow nutrient-rich sections of other Ontario lakes, provide such ideal habitat for zebra mussels that today researchers discuss not how to get rid of them, but how to live with them. It's a hard lesson, and one that is costing Ontario residents millions of dollars, with no end in sight. What's more, unless the public takes their threat seriously, zebra mussels may invade inland waters where they can cover existing docks, rocks and other solid objects with over 30,000 and sometimes up to 100,000 animals per square metre.

People are largely responsible for the spread of zebra mussels. Boats and ships have spread the mussels, attached to hulls and outboard motors, upstream throughout the Great Lakes. Mussels have also been identified on at least one boat in the Ottawa area. Zebra mussels, especially in the veliger stage, can also be transported in water, such as baitfish water taken from an infected lake, or within lights or other small spaces on boat trailers. Invisible to the naked eye, veligers in such water could colonize a previously mussel-free lake.

Researchers hope that the mussel's spread might exclude northern Ontario waters, which are deficient in calcium, and the extreme north, where summer water temperatures barely climb above 12 C.

Established Zebra Mussel Populations in the Great Lakes December 1990

ACKNOWLEDGEMENTS

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SO YOU THOUGHT ACID RAIN WAS BAD!

Acid rain. The Exxon Valdez oil spill. According to some environmentalists, these problems are minor compared to the possible long-term impact of the zebra mussel. Any new species could disrupt the ecology of the Great Lakes. But one with the adaptability and habits of the zebra mussel is a major concern.

Here's what they do:

- Strain lake water and remove particulate matter, thus making plankton unavailable to microscopic crustaceans which feed the larval and juvenile fishes, and unavailable as well to plankton-eating forage fish which support the sport and commercial fisheries.
- Clear Lake Erie's murky water, affecting walleye habitat because walleye prefer waters with low light penetration.
- Concentrate toxic pollutants.
- Cover traditional walleye, bass and whitefish spawning beds.
- Alter surrounding oxygen and pH levels, possibly influencing walleye, white bass and smallmouth bass hatching success.
- Compete with native clams.
- Clog intake pipes of thermal power stations and municipal water treatment plants, reducing water flow in some cases by more than 50 per cent.
- Weigh down and sink channel marker buoys, causing boats to run aground and necessitating costly buoy replacement.
- Attach to boat bottoms, increasing drag and fuel consumption.
- Clog engine inflows, reducing the amount of engine cooling and resulting in costly repairs to overheated engines.
- Dead mussels may contaminate Lake Erie beaches, making them unsuitable for swimming.

There are some silver linings. Zebra mussels may:

- Make people more aware of the amount and kind of damage done by non-native species.
- Provide excellent market opportunities for innovative businesses selling everything from new displacement pumps with cleaning nozzles for use in cleaning off zebra mussel-contaminated surfaces, to a biodegradable spray-on rinse for removing veligers.

Intermediate/Senior

The scaup is a diving duck known to eat zebra mussels in Europe. Observers at Point Pelee have noticed that the number of migrating scaup has increased over the last half decade:

Maximum autumn count of scaup, Point Pelee

1985 — 20
1986 — 20
1987 — 20
1988 — 70
1989 — 13,500
1990 — 17,500

Observers also have noticed that scaup now stay in the area longer. Does this evidence suggest that scaup might be eating zebra mussels? How could scientists verify this observation? Do research to find out why scaup aren't the answer to zebra mussel problems. What are the disadvantages to having such high numbers of a migrating species together in one place at the same time? What might happen to a species that consumes large numbers of animals that concentrate toxic pollutants?

A POUND OF CURE

So what's the cure? Sadly, prevention would have been. Over the last 200 years, no one in Europe has been able to develop a lake-wide control that wouldn't harm other aquatic species. North Americans are not likely to come up with one in less than a decade.

Nothing can be done to eliminate zebra mussels. However, a number of controls are being used and developed.

CONTROLS BEING USED

USER	CONTROL METHOD	ADVANTAGES/DISADVANTAGES*
Ontario Hydro	chlorinate intake water	+ effective - kills other species - not registered as a pesticide, so would need special certification from Agriculture Canada - dead bodies pollute the water taken in
Tilbury water plant	infiltration bed	+ prevents veligers from entering intake pipes – costs $1.2 million

EXPERIMENTAL CONTROLS

METHOD	ADVANTAGES/DISADVANTAGES*
heat	+ takes only 15 minutes at 40 degrees C to kill zebra mussels + can be used to remove them from equipment taken out for maintenance and repair - difficult to apply heat to underwater structures
potassium phosphate	+ will kill at low concentrations + doesn't harm two other tested species - not registered as a pesticide - general and long-term effects not known
extract from African soapberry plant	+ supposed to decompose in water within 24 hours without leaving toxic residue - no definitive results yet
sound	+ low intensity sound reduced the number of settling larvae + high intensity sound disabled larvae and fractured the shells of recently attached juveniles

*+ = advantage; - = disadvantage

WHAT CAN YOU DO?

If you're a boater, angler, cottager, scuba diver, swimmer, or other water user, you can help prevent the spread of zebra mussels. Here's how:

1. NEVER, for any reason, move zebra mussels.

2. Do not take water from one lake and deposit it in another. The water could contain zebra mussel larvae. When you want to transport live baitfish, transfer them to well water or uncontaminated water before moving them. Unless you can return lake water to the place you obtained it, pour it on the ground well away from a water body. Don't flush it down the toilet, or pour it into a sewer or sink as this may introduce zebra mussel larvae to a new area.

3. Clean all equipment before moving it from an infested lake. This includes boats, paddles, scuba tanks, anchors, beach pails, and any other gear that is damp or has come into contact with the water. Clean it off with a solution of 15 ml of bleach to 4.5 litres of hot, soapy water. Alternatively, use high pressure water (at least 250 pounds per square inch), a steam cleaner, or leave your equipment for two or three days in a hot, dry area (the mussels will die). If wood and metal objects are infested with mussels, use a paint scraper to remove the finish **down to the bare wood or metal,** and repaint.

4. Soak live wells and bilges with the bleach solution.

5. Do all cleaning well away from water bodies or sewer systems.

6. Dispose of mussel residue in a garbage bag or other container. Don't allow it to run back into a water body.

By practising these techniques, you can help slow the spread of zebra mussels while scientists search for a way to control them. It's worth a try!

ACTIVITY INFORMATION

Grade Level:
Primary/Junior

Subject:
Science

Duration:
1 hour

Setting:
Gym, or other area with a large, clear space

Concepts:
basic needs, carrying capacity, introduced species

Attitudes:
concern for the environment, curiosity

Skills:
observing, communicating, predicting, interpreting

Knowledge:
community, life, change, growth, interrelationships

Vocabulary:
basic needs, carrying capacity, community, competition, invader, plankton, predation, space, unionid clam, yellow perch, zebra mussels

SUMMARY

Students will become clams, yellow perch, walleye and zebra mussels in an active competition for basic needs.

OBJECTIVES

Students will be able to:

1) describe at least two factors which contribute to the carrying capacity of a habitat;

2) identify at least two effects of zebra mussel invasion on the established community; and

3) provide at least two reasons why zebra mussels are successful invaders.

TEACHER BACKGROUND

All living things have basic needs for food, water, shelter and space. Any area has just so much of these needs for each kind of plant or animal living there. The number that can be supported is termed the carrying capacity. The carrying capacity may vary from season to season or year to year, and will be affected by variations in the amount of food, water, shelter and space, or by competition for these things with another plant or animal. In this activity, the carrying capacity of a lake community for native clams and yellow perch is affected by the arrival of zebra mussels, and competition with the mussels for food and space.

Unionid clams are large (up to 25 cm), native clams which live in sand or mud bottoms and filter small floating plants and animals called plankton out of the water. There are usually less than 10 clams per square metre. Zebra mussels compete with clams for food and space. Although mussels cannot live in the soft bottom like a clam, they will attach directly to the hard surface of the clam itself in large numbers, eventually smothering it.

Yellow perch is an important game and commercial fish especially common in the Great Lakes. Newborn perch feed on plankton, and so directly compete with zebra mussels. Another factor which limits populations is predation. Many larger fish prey on yellow perch, but few predators will eat zebra mussels. Thus mussels can expand to the limits of their food supply, but yellow perch cannot.

MATERIALS

Tape or chalk to mark circles (if gym unavailable); two hula hoops/circle, or rope, yarn or string; enough newspaper cut into quarter sheets to make 300 balls.

ADVANCE PREPARATION

If you aren't using a gym, mark off one or more 2.5-3 m (8-10') diameter circles on the floor (each circle will accommodate about 20-25 students). In each circle, randomly place two hula hoops or loops of rope, yarn or string about 1 m in diameter. Within the hoops or loops, stick a small piece of masking tape to the floor. Crumple the newspaper into 300 tight balls (students may do this as part of the activity).

PROCEDURE

1. Review or establish the concept of basic needs. Indicate that students will try to meet some of their needs by becoming a clam, perch, or zebra mussel.

2. Lead each group of students to their circle. Have them mill around in the circle. Tell them that they are baby clams trying to find a good place to live (they can't stand still because baby clams drift with the currents. Yell, "Stop!" Everyone not standing in a hoop or loop should step out of the circle. Tell them that one of the clams' needs is a muddy or sandy bottom, and that only the areas inside the hoops or loops are muddy/sandy. If there are more than one person inside the loops, have them mill again, and stop. The person nearest the small piece of tape has found the very best spot and can stay. The others must leave. Have the two surviving clams sit down on the piece of tape. Emphasize that finding the right kind of bottom at just the right time is very important for the clams, and can limit their numbers.

3. Identify two students as "plankton producers". Have them sit with their backs to the circle, and toss plankton (paper balls) at random over their shoulders into the circle to simulate plankton floating free on the currents. The clams must catch the plankton in the air to simulate feeding. Anything missed stays on the ground, since clams do not have hands to pick things up. (You might want to assign "scavengers" the job of picking up balls and returning them to the producers.)

Unionid clam with attached zebra mussels. Clear part of shell was buried in bottom mud.

4. Identify three yellow perch, and add them to the circle. Indicate that they are very young perch that also eat plankton. They can move around the circle and try to catch plankton in the air, but they can't block off the clams. They can also pick plankton off the "bottom". After a few minutes, add two walleye, larger fish that can eat the yellow perch. The walleye run around the outside of the circle, reaching in and trying to tag (eat) the yellow perch. Tagged perch must leave the circle. Perch must then avoid the walleye and catch food. As perch are eaten, add more at your discretion. Try to maintain at least one perch until the circle starts to get crowded and food to the perch is severely reduced. Then, if the last perch is "eaten", do not replace it.

5. Begin to add zebra mussels. Indicate that they can live on any hard surface, i.e., anywhere outside the hoops or loops, and feed the same way the clams do. Gradually add more mussels. As it gets crowded, indicate that since mussels can stick to each other, they can sit in the hoops or loops as long as they are touching another mussel outside the hoops or loops. You may have to prompt students that the clams are also a "hard surface", as are other mussels. Continue until all the clams are sat on, as well as some of the mussels.

6. Discuss, from the fish and clams' points of view, what happened as more mussels were added. Did they continue to get as much food? Was it harder to get food? What did the yellow perch have to put up with that the zebra mussels didn't? Were the clams getting anything at the end, or were they "smothered"? Did the mussels have to compete with anything else for space? Were any zebra mussels smothered? Did that mean there were fewer zebra mussels? Who had the advantage in this activity? Why?

EVALUATION

Based on what they've learned in the activity, have students come up with, and defend, a way to control or reduce zebra mussels, before or after they settle in an area. What would happen to the yellow perch and clams? If possible, modify and redo the activity, and see if fewer mussels result.

EXTENSIONS

1. Set a time period, and determine how much food the clams, mussels and yellow perch need to survive (e.g. six pieces per clam, eight pieces per perch, and two pieces per mussel each minute). Determine when the clams, perch and mussels begin to die due to overpopulation by the mussels.

2. Discover the problems zebra mussels are causing in coal-fired electrical plants and water treatment facilities, and why water intake pipes make good habitat for zebra mussels.

LESSON INFORMATION

Selected Curriculum Links:

Grade 7/8 Geography, Patterns in Human Geography - Patterns in our Community

Grade 9/10 Geography, Geography of Canada - Natural Resources

Grade 10 General Science - Community Ecology

Grade 10 Advanced Science - Interactions; Organisms and their External Environment

Grade 10 General Environmental Science - Ecosystems

Grade 10 Advanced Environmental Science - Population Ecology

Grade 11 Applied Biology - Humans and the Environment

Grade 11 General Environmental Science - Wildlife Biology; Aquatic Ecosystems

Grade 11/12 Geography, Environmental Studies - Ecosystems; Preservation, Conservation and Environmental Management

Grade 12 Basic Science - The Changing Environment

Grade 12 Advanced Environmental Science - An Aquatic Ecosystem Study; Fish and Wildlife Conservation

Setting:
Classroom, School and/or Community

Duration:
5-6 hours of class time, spread over several weeks; out-of-class variable, depending on type of assessment and campaign chosen.

Key Terms:
Introduced species, competition, zebra mussels, carrying capacity, survey, questionnaire, public information

SUMMARY

Investigate and assess the effect of MNR's public awareness campaign on your local community. Tell us what you've found, and design your own zebra mussel message to meet the identified needs of your community.

OBJECTIVES

Students will be able to:

1) explain the threat zebra mussels pose, as well as the reasons for existing control measures;
2) describe the effectiveness of the zebra mussel campaign on their local community; and
3) develop and deliver at least one additional educational/communications vehicle aimed at the local community, based on the assessment of local needs.

TEACHER BACKGROUND

Zebra mussels have the potential to affect many of the water-based communities of Ontario. In this lesson, students have the opportunity to become involved in this fisheries management issue, and make an ongoing contribution to the control of zebra mussels.

The basics of the zebra mussel situation have been presented elsewhere in this newsletter, and in other available publications (see References). This information can be provided to the class in written form as the basic information necessary to complete the lesson.

The next step will be to design a way to judge how well this information is getting across to the public. This step will include some method of data collection, for example: a general questionnaire to be included in a power bill or other fairly broad mailing; a phone survey; personal interviews conducted at stores, shopping centres, etc.; a more selective sampling of the public that uses the water, including anglers and boaters. The last could include surveys of fishing clubs, personal interviews, or questionnaires completed at boat docks.

Once the data is collected, it must be analyzed. Basic percentage comparisons can be used to determine if particular segments of the public are or are not getting the message, what portions of the message are or are not being retained, and whether people are acting on that knowledge.

Finally, if the students have identified a need for additional information or action related to zebra mussels, they can design their own "campaign", tapping into such local resources as newspapers, cable TV companies and radio, or water-related enterprises such as bait shops, marinas, or boat launches. Campaigns can be "personalized" using student artwork, music, jingles, etc.

MATERIALS

Class sets of zebra mussel information from this newsletter, and from other sources (see References); materials as needed for public information campaign.

ADVANCE PREPARATION

Distribute and assign zebra mussel information as homework.

PROCEDURE

1) Prior to the homework assignment, ask students what they know about zebra mussels. Have them write down the following:

   a) what zebra mussels are, where they come from, and how they got to Ontario
   b) the actual and potential effects of zebra mussels
   c) ways people can help control the spread of zebra mussels
   d) where they got their information

   Have the students compare their answers to the content of their homework assignment.

2) Discuss the homework assignment, particularly the need to control the spread of the mussels, and the role of the general public in that control. Based on the student's initial response to the questions posed in step one, do they think the public in general is well-informed about zebra mussels?

3) Challenge the students to discover the effectiveness of MNR's zebra mussel information campaign in their local community by:

a) identifying the ways zebra mussel information has reached the community, including local, regional and/or province-wide media (electronic or print), posters or brochures, and word-of-mouth. For example, how many articles on zebra mussels have run in the local paper? What were they about? Where were they? Were they aimed at a particular audience?

b) assessing the accuracy of the information. Was it distorted in any way? Were there any factual errors?

c) determining the level of awareness and knowledge about zebra mussels in the local community. Who knows of zebra mussels? About zebra mussels? Has anyone changed their behaviour as a result?

4) Have the students assess their results. Is the right information reaching the right people? Where are the gaps? What still needs to be done? Share your findings with your district MNR office.

5) As a class, design and implement a supplementary information campaign, based on the needs identified in Step 4. Be sure to check any content with your district MNR office, and obtain necessary permissions for signage.

EVALUATION

Have the students design a method for evaluating the success of their campaign, and carry out the evaluation.

EXTENSIONS

1) Approach art/design and/or media/ communications classes for help with graphics or communications planning.

2) Have students involve a local elementary school in a poster contest as part of your campaign. Use the contest and resulting artwork to get local media coverage.

3) Create a "Zebra Mussel Watch". Find likely zebra mussel habitat in a local lake or pond, or place a suitable solid surface in the water, and check it regularly for signs of colonization. Report any "sightings" to the local MNR office.

NOTE: Please do not remove and transport zebra mussels for any purpose — accidental contamination of other water bodies may result.

4) For younger ages, you may wish to limit your assessment and information campaign to all or part of the school population.

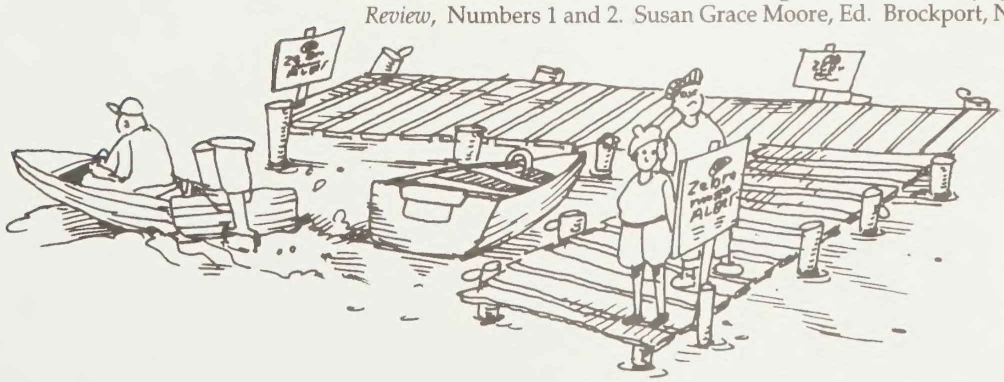
REFERENCES

Ontario Ministry of Natural Resources. *Zebra Mussel Informer*, Numbers 1 and 2, 1990.

Ontario Ministry of Natural Resources. *Zebra mussels.* What you should know. Brochure available from district offices and public information centres: 1990.

Ontario Ministry of Natural Resources. *Zebra mussels.* Fact sheet available from district offices and public information centres: 1990.

New York Zebra Mussel Information Clearing House. *Dreissena polymorpha Information Review,* Numbers 1 and 2. Susan Grace Moore, Ed. Brockport, NY: 1990.



Immerse your class...in Ontario's aquatic resources

FISH ways

Manuals for Fisheries Education

WHY DO WE NEED FISHERIES EDUCATION?

Almost one-fifth of Ontario is water. Hidden within is an abundance of fish that supports extensive sport and commercial fisheries, and contributes to the stability and productivity of our waters. Management of this vast, dispersed resource requires the active participation of all Ontarians. We need to know the "ways of fish", and to pass on that knowledge to our young people, so that they can make responsible decisions about Ontario's fish both now and in the future.

WHAT IS FISH WAYS?

An active, hands-on approach to fish, fish habitat, and fisheries management for young people aged 5-18. It provides a range of opportunities, from simple indoor activities requiring little preparation and few materials to detailed, on-site inquiries into the effects of our activities on local aquatic resources.

WHO CAN GET INVOLVED?

Anyone who educates young people, including teachers, scout and guide leaders, and parks, recreation and outdoor education centre staff.

HOW DOES FISH WAYS WORK?

Developed by classroom teachers, outdoor educators and fisheries biologists, Fish Ways links directly to the Ontraio curriculum in science and geography. At the elementary level, it can be used to enrich other subject areas. Two manuals, one Primary/Junior and the other Intermediate/Senior, provide selected experiences which match the ability levels of any given age. Each activity or lesson is self-contained, providing all necessary background information, objectives, basic procedures, a means of evaluation, and ways to take the learnings further.

WHEN WILL IT BE AVAILABLE?

Fish Ways will be available in October 1991.

HOW CAN I OBTAIN A FISH WAYS MANUAL?

First, by attending a one-day Fish Ways Workshop, you can experience and lead a number of Fish Ways activities, interact with other leaders and MNR staff, and receive your manual free. There is no registration fee for the workshop, but you are responsible for your expenses.

Second, if you have attended either a Project Wild or Focus on Forests workshop, you will be able to purchase the appropriate manual(s).

WHAT DO I DO NOW?

If you want to attend a workshop, purchase a manual, or receive more information on Fish Ways, check the proper boxes on the enclosed reply card, or send your request to:

Fisheries Education Coordinator
Ontario Ministry of Natural Resources
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